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OUR WORLD OF SCIENCE

Working With Science

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OUR WORLD OF SCIENCE

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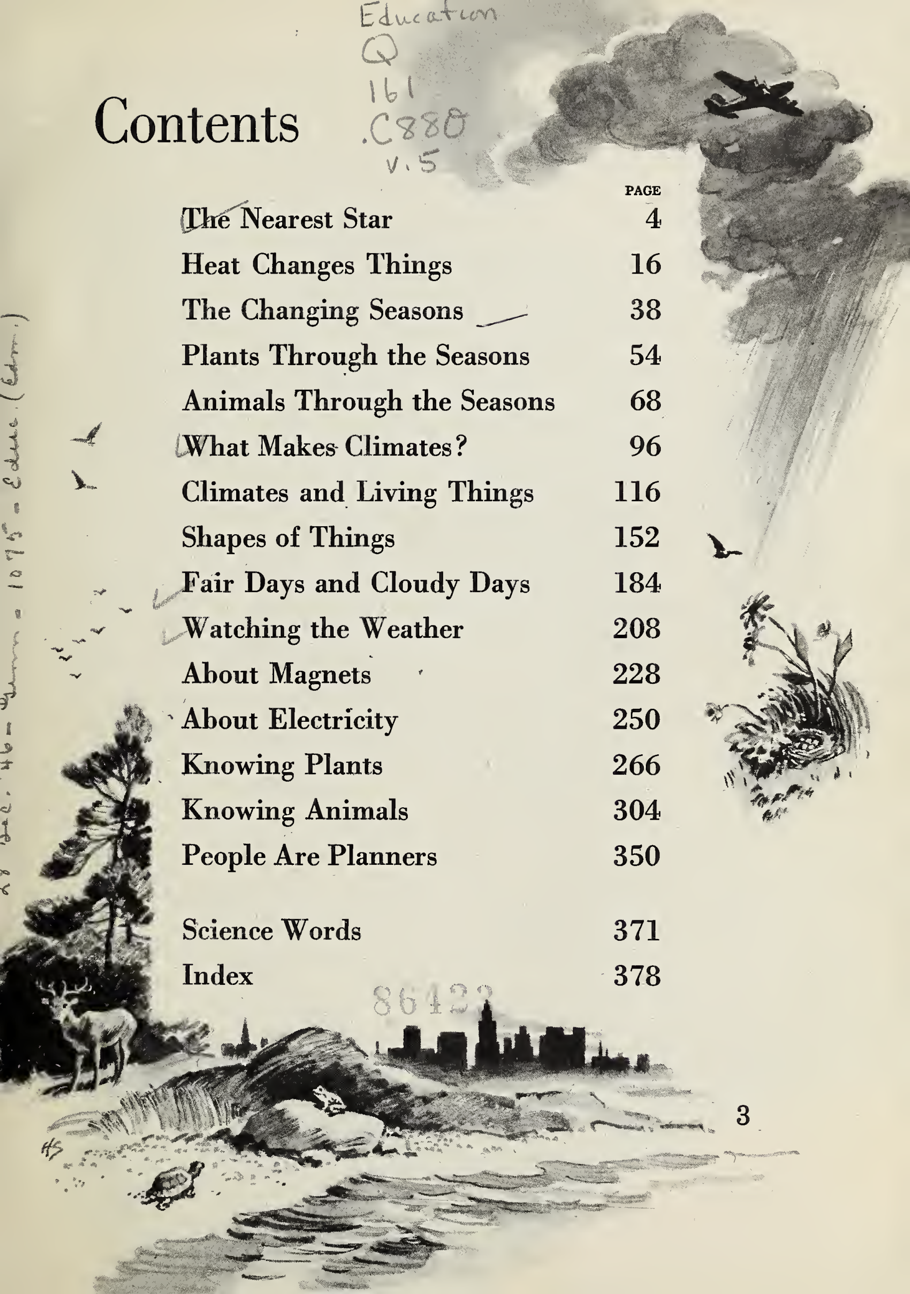

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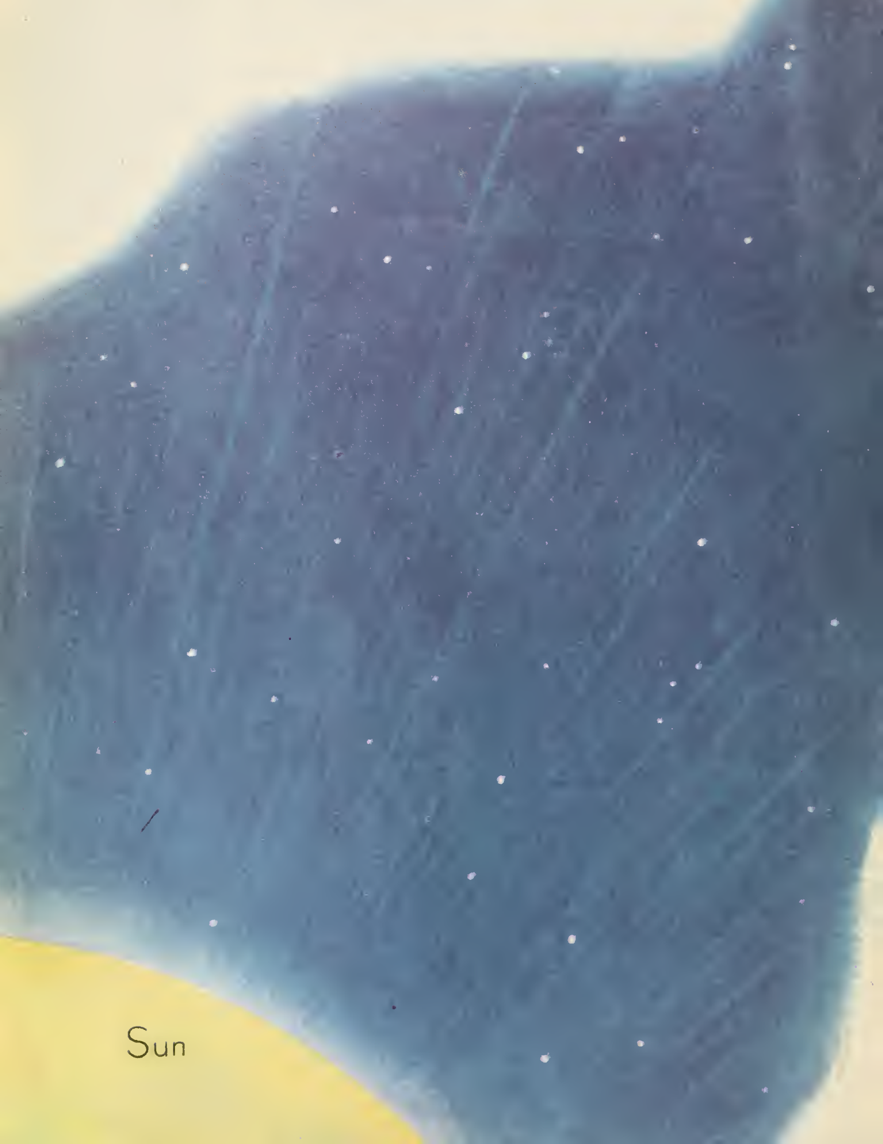
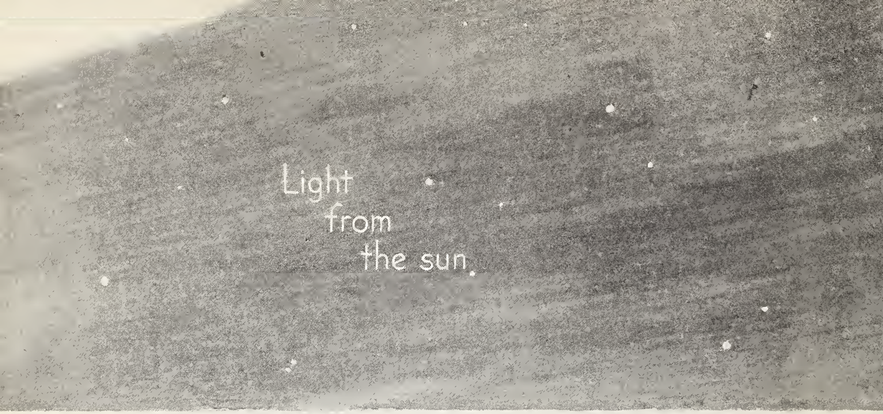
The Nearest Star



Our Large Sun

How many stars there are in the sky! Did you ever try to count them? You probably found that you could not do it.

Many, many stars can be seen directly on a clear night. But these are not all the stars. There are millions and millions of other stars which you can see only with a telescope.



Light from the sun

There is one star which is very easy to see. Yet we never see this star at night. We see it only on a clear day. This star is our sun. We cannot see it during the night because the earth is always turning. During the time we call night, the place where we live is turned away from the sun.

Try to find, in the picture on the opposite page, the place where you live. Is the place where you live having day or night? You can see that there are other stars all around the earth. Why can't you see the other stars in the daytime sky?

There are many, many other stars in the daytime sky. You do not see the other stars because the sun is so very much nearer to us than the others. Though our sun is only a medium-sized star, it is so near us that it looks brighter and larger than any other star in the sky.

Look at the picture again. Suppose you could see all the other stars in the daytime sky. Would they be the same stars that you see during the night? Why wouldn't they?

You may be wondering why the other stars look so different from our own star, the sun. They really are very much the same as our sun, except that they are much farther away from us. Have you ever noticed how different things look when they are close to you and when they are far away from you? They always look much smaller when they are far away.

When you throw a ball into the air, it looks smaller and smaller as it goes away from you. As it comes back to you, it looks larger and larger. An airplane that carries many people looks very large when it is on the ground. How small it looks when it is flying high!

Though this middle-sized star, our sun, does look larger than the other stars, it is hard to imagine how very large it really is. The sun is ever and ever so much larger than the earth. It is over a million times as large as the earth. Perhaps this picture will help you to imagine how large the sun is.

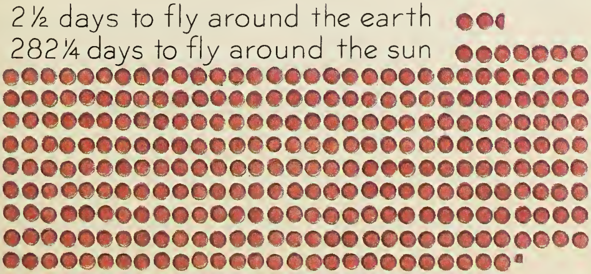
You may try to understand the sizes of the earth and sun in another way. Make a ball of clay with a diameter, or distance through the center, of one-half inch. We will pretend that this is the earth. Now draw on the floor of your room or on the schoolground a circle to represent the sun. This circle must have a diameter of fifty-four inches. Can you imagine a ball with a diameter this large? Now look at your clay earth-ball. How very large the sun is!

The diameter of, or distance through, the sun is about 864,000 miles. This is one hundred nine times the earth's diameter. Suppose you could fly right through the sun in an airplane going 400 miles an hour. It would take you two thousand one hundred sixty hours, or ninety days, to make the trip. It would take you almost three months!

Suppose you could fly straight through the earth in this same airplane. It would take you only about twenty hours, or a little less than one day.

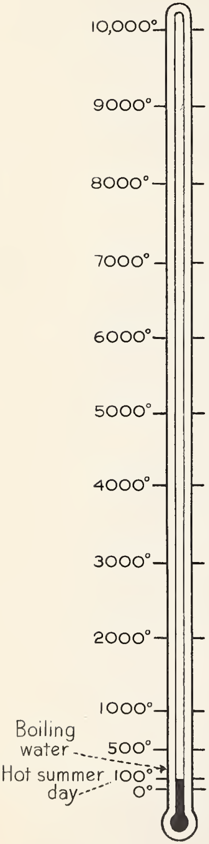
Here is another "suppose" trip. Suppose you could fly all the way around the earth, at the equator, in this same airplane. Suppose you flew all day and all night at a speed of 400 miles an hour. It would take you about two and one-half days to fly around the earth.

Now suppose you could fly all the way around the sun in your airplane. Suppose you traveled 400 miles an hour, day and night. It would take you almost two hundred eighty-three days, or nine and one-half months, to fly around the sun. How huge the sun is!



Our Bright, Hot Sun

The sun is different from the earth in another way. The earth would be very cold if it were not for the sun. Our sun gives us light and heat. The sun does not depend on any other star for light and heat. It is a giver of light and heat.



This is not true of the earth. We can make fires and burn things on the earth, but the earth itself is not hot and bright. The earth is warmed and lighted by the sun. Though the sun is far away, it is so hot and so bright that it warms the earth.

Do you remember how hot it was on the hottest day last summer? The thermometer may have read 90 degrees, or it may have read even 100 degrees. You probably remember that you wore cool clothes. You probably didn't feel very much like playing in the sun.

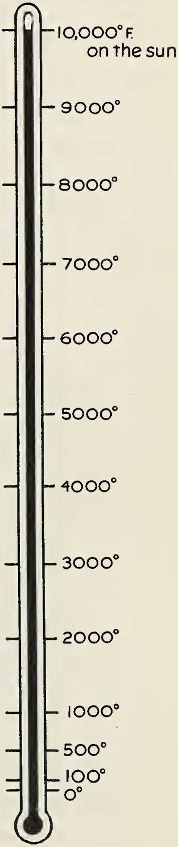
When water boils, it gets very hot. If you should put a thermometer in a pan of boiling water, the mercury in the tube would go up to 212 degrees.

Yes, a summer day is hot. Boiling water is even hotter. But if you could put a thermometer on the surface of the sun, it would read much more than 90 degrees. Your thermometer would read much more than 212 degrees.

Scientists say that the temperature at the surface of the sun is about 10,000 degrees. You would need a very special kind of thermometer to show this temperature. The thermometer you have in your room would turn to gas at this great heat.

This huge ball, our sun, is made of hot gases. It is not solid in the same way that a rock is solid. There is no ground for you to walk on. To try to walk on the gases of the sun would be something like trying to walk on air. If you stepped on the sun you would sink into it. But you could not go as far as the center, because the gases there are packed too closely together.

The sun's gases are so hot that they give off light. They are much warmer than a red-hot stove. The sun is hotter than anything we know about on the earth. It is hotter than the hottest fire.



Do you suppose you could live near such a hot mass of gases as the sun is? No, of course not. You would turn to hot gases, too. It is even dangerous to try to look at our shining, bright sun. It is so very bright that it hurts our eyes.

No, we could not live on the sun. Nothing could live on the sun, our nearest star. But without this star's light and heat, there would be no living things such as we know on the earth. Without the sun's light, green plants could not make food. Without the sun's heat, all living things would freeze.

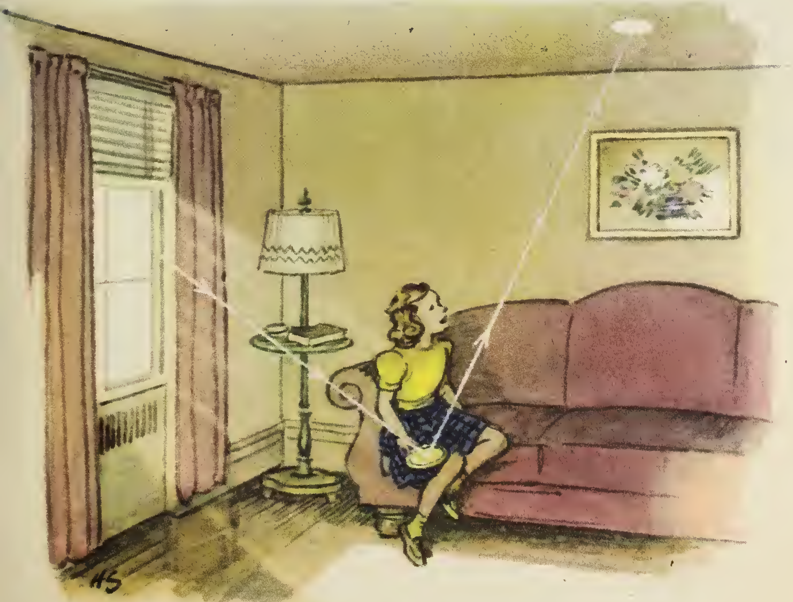
Light from the Sun

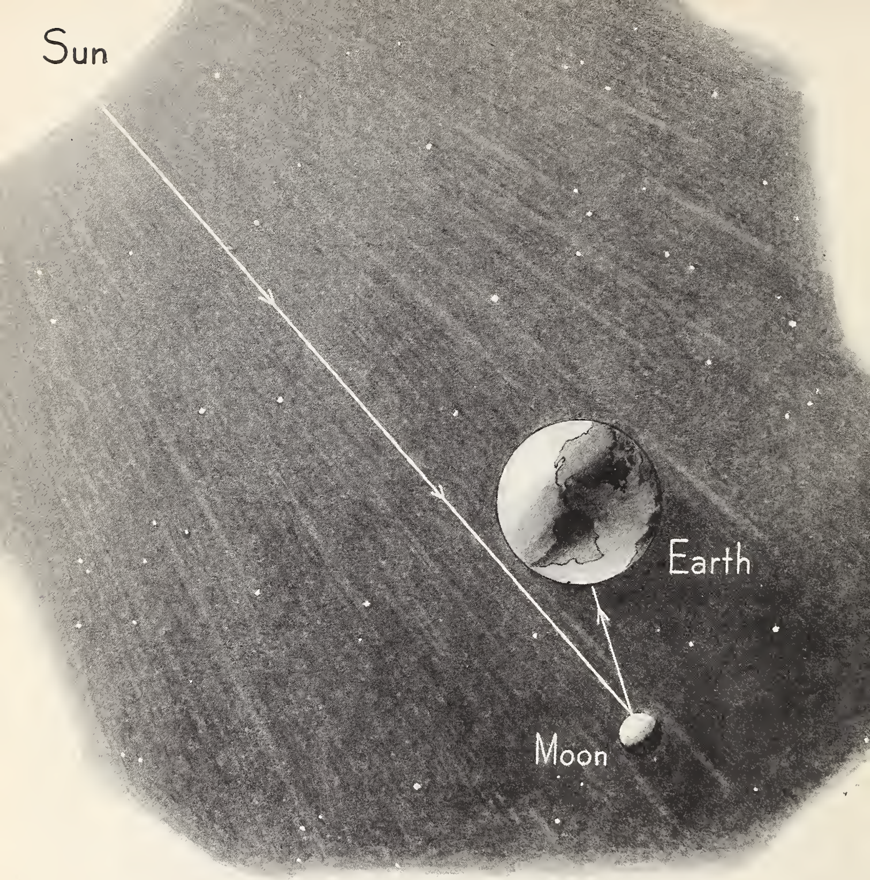
When objects are hot enough, they give off light. We have seen that the sun does. So do other stars, electric lights, candles, matches, bonfires, and many other things. When light from any of these objects strikes our eyes, we see. We call stars, electric lights, matches, candles, and bonfires sources of light.

But how is it that we are able to see our hands, feet, trees, houses, furniture, people? These things do not give off light of their own. They are not sources of light.

Should you like to see if your hand is a source of light? Go into a very, very dark closet. Make sure that no light comes through the keyhole or from under the door. Hold your hand before your eyes. Can you see your hand? No, it is not a source of light. Can you see the walls of the closet? Now let light into the closet. You can see the walls of the closet, your hands, your feet, and anything else in the closet.

We say that those things on which light falls reflect light. To reflect light means to turn light back to you. A mirror reflects light very well. Hold a mirror so that the sunlight falls on it. Can you make light dance about the room? The light strikes the mirror and is turned back, or reflected.





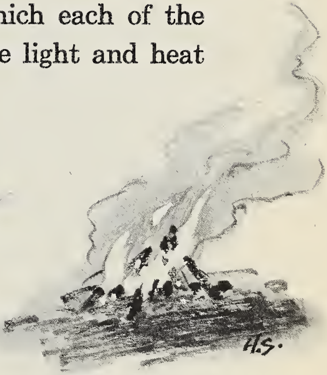
The moon is not a direct source of light, but it reflects sunlight very well. It acts like a giant mirror. The sun shines on the moon, and the sun's light is reflected to the earth. We call this reflected light of the sun, moonlight.

Our nearest star, the sun, is very important to us. Though it is only a medium-sized star, it gives us light and heat. It is our most important source of light. The sun really gives us moonlight, as well as sunlight.

SOMETHING FOR YOU

1. Suppose there should suddenly be no more sunlight. Describe your life on the earth without the sun.

2. Try to think of the way in which each of the things in the pictures below uses the light and heat from the sun.



Heat Changes Things

Early Man Discovered Fire

"Will you put some water on to boil?"

"Will you bring in some wood to build a fire?"

"Put some matches in the picnic basket. We'll build a fire at the beach."

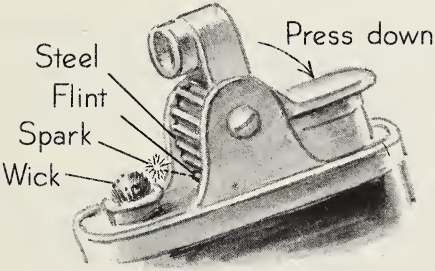
Have you ever heard your mother say any of these things? Each day she uses fire. Your mother uses fire for cooking, for heating the house. Could you think of other ways in which she uses fire?

No one knows when or how man first discovered how to make a fire. It may have happened in this way: He often made stone tools or arrowheads. Tiny sparks sometimes appeared when he hit two stones together. These sparks were hot. They may have fallen on dry leaves and set them on fire.

After that, early man knew he could make a fire any time he wanted one. He could carry his hard, "fire-making" stones about with him. He could always find dry leaves and dry wood for fires.

You may have made a fire at some time in much the same way as early man made fire. Have you ever used very hard stones, called flint, to strike a spark? You probably struck the sparks just above dry leaves. When the sparks fell on the leaves, the leaves caught on fire. If you have never done this, you might try it sometime. Be sure to use very hard stones, such as flint, and very dry leaves.

For a long, long time man made fires by striking pieces of stone together. The early settlers in this country always kept pieces of flint on the mantelpiece above the fireplace. They used these pieces of flint for lighting fires. Men carried pieces of flint about with them to light their pipes.



Even today we still use this same method for making sparks. Have you ever noticed your father's cigarette or cigar lighter? Ask him to show you how it works. In some lighters a little wheel made of very hard steel strikes a small bit of flint or another piece of hard steel. Sparks are given off. The sparks fall on the wick of the lighter.

The wick of the lighter is made of material which does not burn easily. It is always wet with a liquid which does burn very easily. When the tiny sparks fall on the wick, they set this liquid on fire.

We do not use flints for lighting fires in our fireplaces today, or for lighting our gas stoves. We use matches to do this. But though we make our fires in a different way, we use the heat from these fires for many of the same things that early man did.

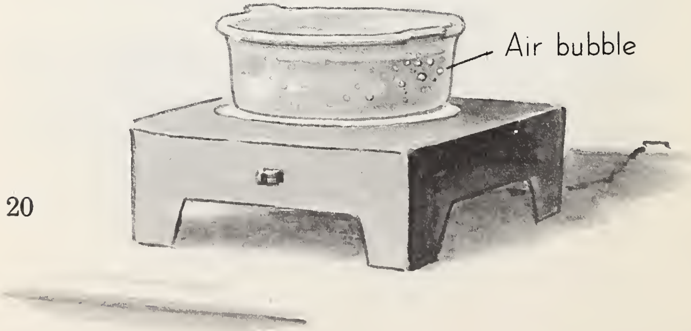
Heat Changes Water

Have you ever really watched water boil? If you use a Pyrex dish, you will be able to see the water boil very easily. If you can't get a Pyrex dish, a metal pan will do very well.

Fill your pan about half full of water and put it on the stove. Of course, if you put the pan on a gas stove, the water will heat quickly. But you can use an electric stove or a coal stove or a wood stove for heating the water.

Air Bubbles

After a while you will notice things happening to the water. Do you see tiny bubbles in the bottom



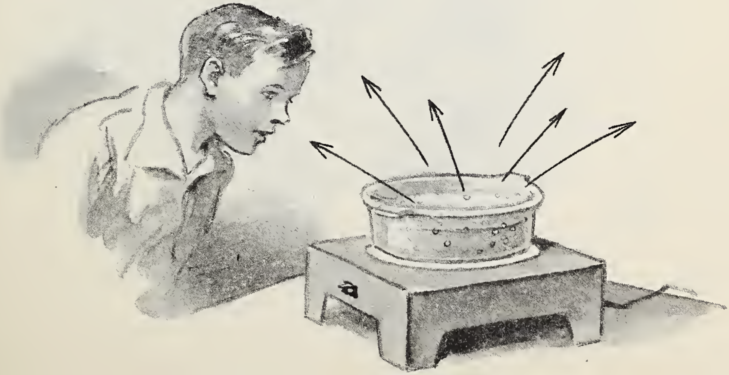
of the pan? Do some of the bubbles break away and come to the top of the pan? These first, tiny bubbles are air bubbles.

Heat is making a change in the water. It is driving the air out of the water. This air is exactly the same kind of air that you breathe. It is dissolved in the water which you are heating.

As the water becomes hot, the air becomes hot. When air is heated, it spreads out. We say it expands. It takes up more room than it did before. The same amount of air has grown warmer and has expanded into a larger space.

These light, expanded bubbles of air float right up through the water. They break at the top of the water and escape into the air in the room. You may be breathing some of the air which was in the water.

Yes, heat changes water. It drives air out of water. Have you ever tasted water which has had air driven out of it? It tastes flat.

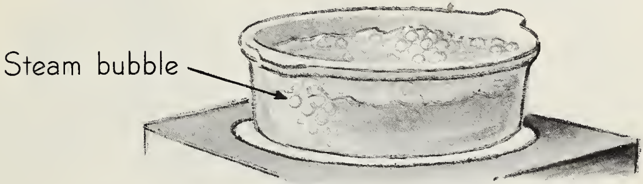


Sometimes drinking water must be boiled before it is safe to use. Can you think of any times when you have had to boil your drinking water? Have you ever done this on a camping trip? Boiling water fifteen or twenty minutes kills many of the germs in the water. Heat makes water safer for drinking.

Killing the germs is not the thing which makes water taste flat. Water tastes flat when there is little air in it. Could you think of some ways to get air back into the water? You could do one of several things.

First you could fill a clean jar about half full of boiled water. Screw a top on the jar. There is air above the water in the jar. Now shake the jar for a few minutes. Some of the air in the jar will be dissolved in the water. The water will not taste so flat now.

Another thing you could do would be to beat the boiled water with an egg-beater. This causes air to be dissolved in the water. Still another thing you could do would be to pour the boiled water from one clean jar to another several times. As water goes through the air from one jar to another, air is dissolved in the water.



Steam Bubbles

Heat changes water by driving the air out. It changes water in another way. First, the water which you heated gave off tiny air bubbles. After a while the bubbles grew larger and larger. They made a noise something like "plop, plop" when they broke at the surface of the water.

These larger bubbles were steam bubbles. Steam is a gas. It is water in the form of a gas. Heat changes liquid water into steam. When the water begins to change into steam, we say the water is boiling. You can see that the boiling water is moving around very rapidly in the pan.

If you boil the water long enough, all of it will turn into steam. The steam will become a part of the air. We say that water evaporates when it goes into the air. Heat causes water to evaporate quickly.

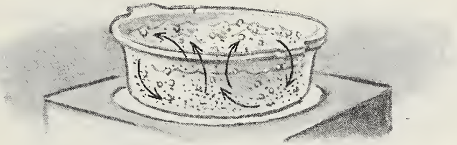
Did you see a white cloud above the pan of boiling water? You may have said, "Oh, look at the steam!" That is what most people say when they see this white cloud.

The white cloud is not steam. Steam cannot be seen. It is invisible. The steam is just above the water. If you look just above the water, you will see what seems to be an empty space. But this space is not really empty. It is filled with invisible steam. Never put your hand in the steam. It is very hot.

As the very hot steam rises into the air, it is cooled by the cooler air. This cooling of the steam causes it to condense, or come together. The steam comes together to form tiny droplets of water, which float in the air. These tiny droplets of water form the white cloud above the pan of boiling water.

You can discover that this white cloud above the pan of water is really water, too. Pass your hand quickly through the upper part of the cloud. Does your hand feel wet? Drops of water from the cloud are now on your hand.

Heat does change water. It drives air out of water. It turns liquid water into steam.



Water Circulates

You probably noticed another thing that heat does to water. You saw that heating the water made it move about. Should you like to try an experiment to see how water moves? Put some water in your pan. Now put about a tablespoon of sawdust in the water.

The water should be still before you begin to heat it. Watch the water carefully as it is heating. What happens to the sawdust?

Does the sawdust in the middle of the pan move about first? Then does it move down the sides? When the water begins to boil, does the sawdust move faster and faster? We say that heat causes water to circulate or to move about.

Heat changes water in at least three ways. It drives air out of water. It causes water to evaporate. It makes water circulate.

Heat Changes Solid Things

Did you ever put your hand on the handle of a metal pan in which something had been cooking for a while? Did you find that it was hot?

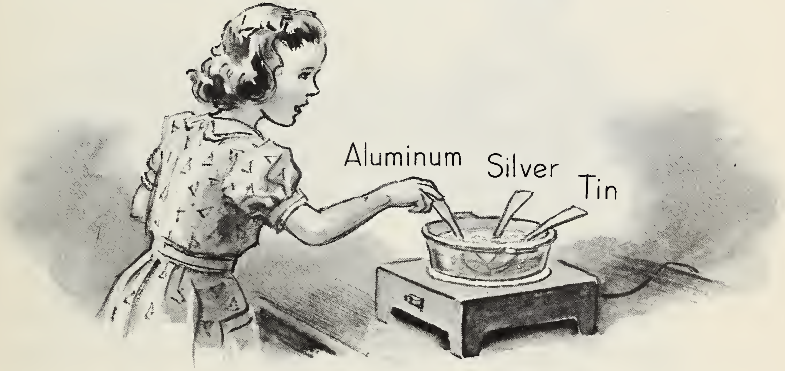
Or did you ever leave a metal spoon in a pan of cooking food and then try to stir the food with the spoon? You probably never tried that again. You learned to take the spoon out of the pan when you were not stirring with it.

Heat Travels

These things certainly show us that heat travels through metals. Heat travels through the metal handle of a pan. It travels through a metal cooking spoon.

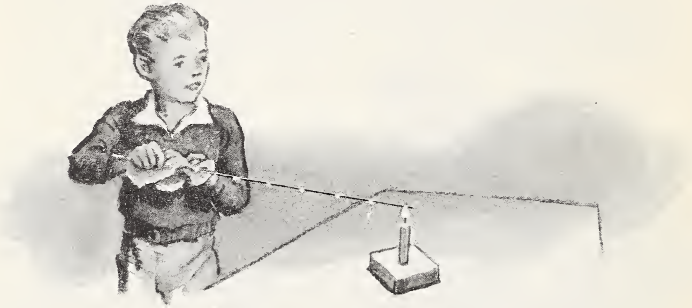
Heat travels through different kinds of metals. Should you like to find out that this is true?

Find spoons of as many different kinds of metals as you can. Perhaps you can find a tin spoon, an aluminum spoon, and a silver spoon. Try to have the spoons about the same size. Now put the spoons in a pan half full of water. Heat the water.



Touch the end of the handle of each spoon from time to time as the water is heating. Do all the handles get hot at the same time? Which handle gets hot first? Heat travels from the water up the handle of each of the spoons. We say that metal spoons conduct heat.

Here is another experiment which may help to show you that a metal will conduct heat: You will need a long piece of metal and some candle wax or paraffin. Press small pieces of the paraffin or wax on the metal rod, just as the boy in the picture has done. Hold the rod so that one end is in a flame. Be sure that you use a pot-holder when you hold the rod.



Watch carefully. Does the piece of wax or paraffin near the flame melt first? Why? Do the other pieces melt and fall after a while?

Some scientists think that heat travels through metals in this way: The bits of metal of which a rod is made cannot move about as freely as drops of water in a pan. But bits of metal do move a little.

The bits of metal in the part of the rod which is near the flame become hot. They move back and forth. They bump into the bits of metal just above them, and make them move. So the movement is passed on from one bit of metal to another all along the metal rod. This is how heat is conducted, or travels, through the metal rod. Of course these movements are so small that we cannot see them, but some scientists think this is what happens.

When the bits of metal in the rod are moving rapidly, we say the rod is hot. If you take the rod away from the flame, it will cool. In other words, the tiny bits of metal slow down. Finally they are moving very little. Then we say the rod is cool.

Larger and Smaller

Heat causes other changes in solid things. Perhaps you have noticed some of these changes. Just as air expands, or spreads out, when it is heated, so a solid expands when it is heated.

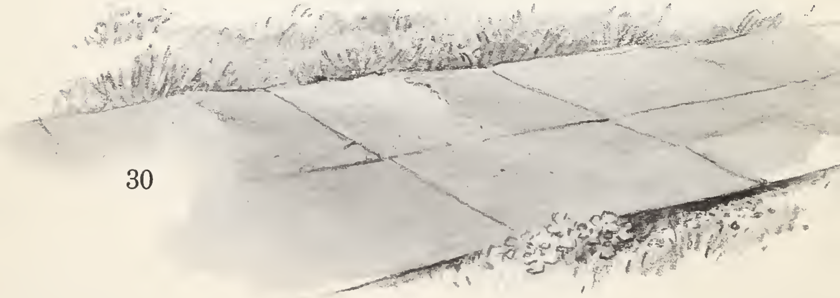
Are there any tar-covered roads near your house? Have you noticed what happens to the tar on a hot summer day? Many times there are little round tar bubbles on the top of the road. The tar has been heated by the sun. It has expanded.

Perhaps there is a cement road near your house. Is there tar in the cracks between the big blocks of cement? You can find tar bubbles on the top of this tar. Sometimes the tar expands so that it is higher than the cement part of the road. Then your car bumps a little as it goes over cracks filled with tar.

Have you ever wondered why cement roads and cement walks are laid in blocks, with cracks between the blocks? They must be laid this way because cement also expands when it is heated by the hot summer sun.

When the blocks expand, they make the cracks smaller. Cracks give the cement blocks room to expand. If there were no cracks in cement walks, they would expand upward and break. The cracks in the cement walk in the picture were not large enough. There was not enough room for the blocks to expand.

When the cement cools, it goes back to its proper place. We say that it contracts, or comes together. If the cement block has been broken by expansion, it cannot go back to its proper place.



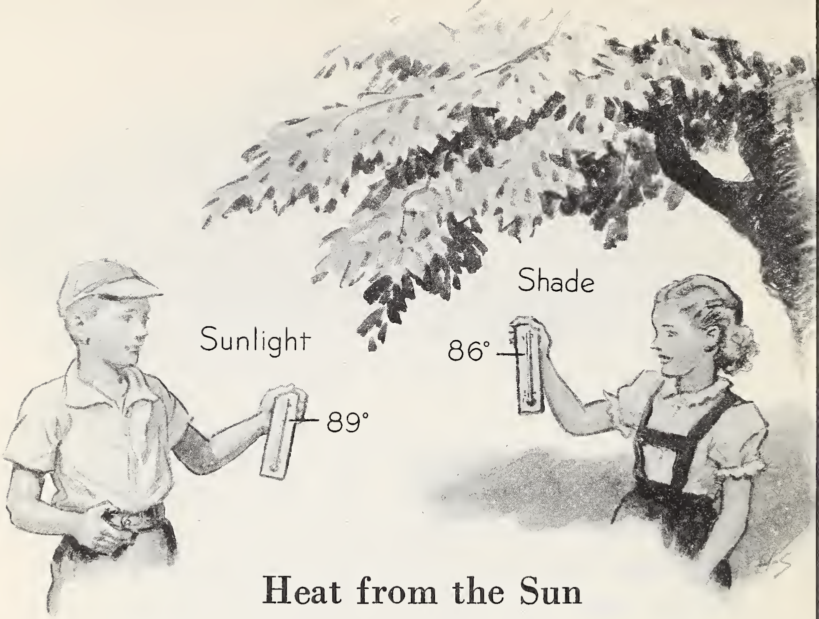
Heat Changes Rocks

Rocks are very solid things; yet heat causes them to change, too. When rocks are heated on a bright summer day, they expand a little. You do not notice that they have expanded, but they have.

In the evening, after the sun has set, the rocks begin to cool. They contract. During a summer day and night, the rocks grow larger and then smaller. After rocks have done this for a long time, bits of rock crack off and fall to the ground. These tiny bits of rock become a part of the soil.

You may be able to find a large rock near your home or school which looks like the rock in the picture. You may find bits of rock on the ground near the big rock.

Heat causes these rock changes. Heat causes the expansion of rocks. When there is less heat, the rocks cool and contract. This causes cracking.



Heat from the Sun

The heat used to boil water comes from the flame of the stove. The heat which travels through a metal spoon comes from the hot water in a pan. But the heat which makes tar bubbles and the heat which makes cement and rocks expand comes from the sun. The sun is a great source of heat.

You can prove this for yourself. Put a thermometer outside in the sun. Watch it for about five minutes. What does the thermometer read? Now move the thermometer to a shady place. Again leave it for about five minutes. Is it cooler in the shade? Do you see that it really is warmer in the sunlight?

The sun gives off heat in all directions, just as it gives off light in all directions. But the earth receives only a very, very small part of this great amount of heat. If the earth received only a little more of the sun's heat, many queer things would happen.

The snow fields in the polar regions might melt. Many plants would wither and die. More water would evaporate from the ocean each day. The sky might be full of huge clouds all the time. What a strange world this would be!

Our Air Blanket

This would also be a strange earth if there were no air. This air, our atmosphere, acts as a blanket around the earth. The atmosphere is all around our earth. It covers the oceans and the land. We walk through the atmosphere. We breathe the air. It is all around us.

Just how does this blanket of air affect the heat of the earth? As you probably know, anything which is heated will give off some heat into the air. Stoves, radiators, and fireplaces give off heat into the air.

Here is an experiment which you can try in order to show that this is true. Heat some water until it reaches 120 degrees. Now turn the heat off. Leave

your thermometer in the pan. Watch the thermometer. Is the water as hot as it was before?

The temperature of the water becomes lower and lower. After about half an hour read the thermometer again. Is the water cooler? Much of the heat of the water has gone off into the air.

Read your room thermometer. Does the thermometer in the water show about the same temperature as the room thermometer?

The temperature of the water in the pan will finally be the same as that of the air in the room. This is because the water has lost most of its heat to the air.

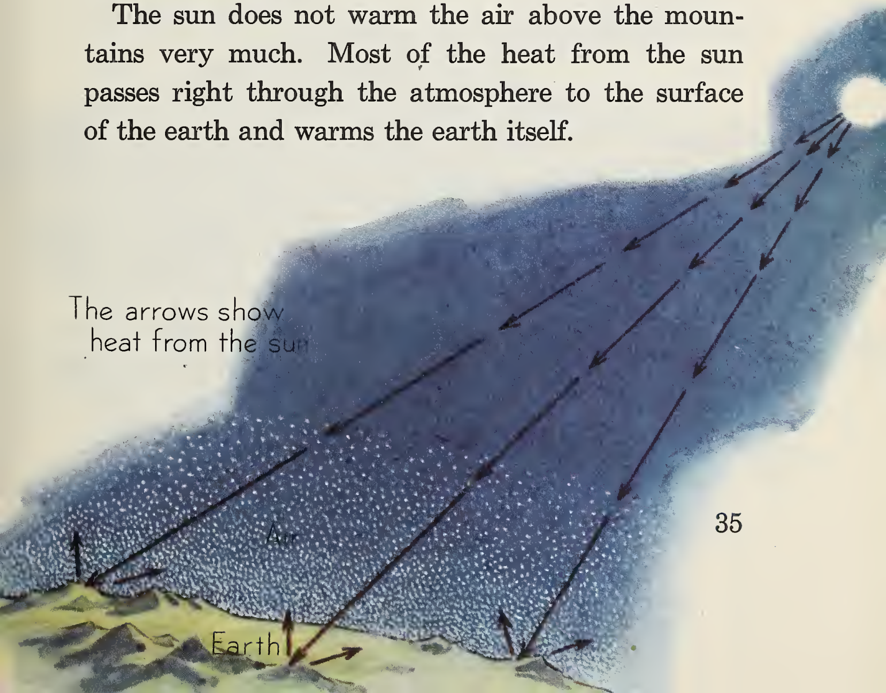
The same thing is true of the earth. The earth is heated by the sun. The heat of the sun comes through the air and warms the land and water of the earth. The earth stores up heat.

Then the earth acts like a huge radiator. It gives off heat in all directions. But there is an atmosphere around the earth, which keeps most of the heat close to the earth. If there were no atmosphere, the earth would lose its heat very quickly. There would be nothing to hold the earth's heat close to us.

Mountaintops and Heat

Some people think the tops of mountains should be very warm. They think this because mountaintops are nearer to the sun than any other part of the earth. Yet it is cold on the tops of high mountains. Just why is this so?

The sun does not warm the air above the mountains very much. Most of the heat from the sun passes right through the atmosphere to the surface of the earth and warms the earth itself.


The arrows show heat from the sun

We live in the atmosphere. Our feet touch the earth, but there is air around the rest of our bodies. If the air around us is warm, we feel warm. If it is cold, we feel cold.

As we go up and up a mountainside, the air becomes thinner and thinner. The air is thinner, or less dense, on mountaintops. This thinner air does not easily hold the earth's heat. So we feel cool on the tops of mountains, though we are nearer the sun.

Heat from the sun or from flames is most important to us. Heat is a great changer of things. We know how to use heat. We use heat to make water turn into steam. We use heat to melt solids. Heat warms our bodies and makes it possible for us to live on the earth.

SOMETHING FOR YOU

1. Why do we cook our food? What does heat do to the food we eat? Sometimes we eat raw foods. Why do we do this?

2. Heat changes solids to liquids. It changes ice to water. It changes solid tar to liquid tar. We call this melting. Name some other solids which can be easily melted.

3. Heat causes evaporation. It makes water evaporate. It also causes other liquids to evaporate. Some liquids evaporate more quickly than water. Put two tablespoons of water in a saucer. Put two tablespoons of rubbing alcohol in another saucer. Which evaporates more quickly?

4. Would your life be different if you lived at some place which received more of the sun's heat than the place where you now live? How would it be different? Think about how you would live if you lived in a place which received less heat from the sun.

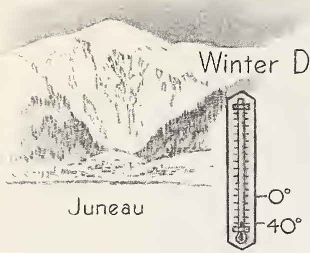
The Changing Seasons

Summer and Winter Fun

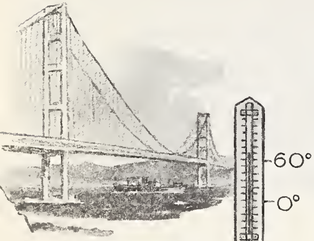
What fun summer is! You can go swimming and fishing and sailing. You can go on picnics and play games in the evening after supper. The summer days are long, warm, and sunny. You have a chance to stay out of doors a great deal.

What fun winter is! If it is cold enough, you can play in the snow or go ice-skating. If there is no snow in the winter where you live, you can go on hikes or play football almost all winter long. Winter days are shorter than summer days. They are cold and snappy. Winter days make you feel like taking lots of exercise.

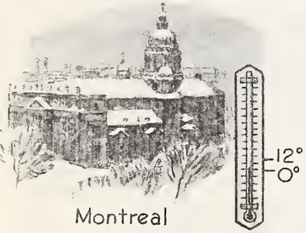
Winter Days



Juneau



San Francisco



Montreal

Spring and fall are fun, too! Do you remember playing your first game of baseball last spring? Do you remember seeing the first green leaves on the trees?

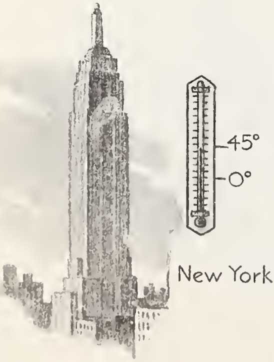
Didn't it feel good to take off your heavy winter coat and play outdoors in a light coat or sweater? The spring days grew longer and longer. They grew warmer and sunnier. Then summer was here.

Fall is football time and the time for raking and burning dead leaves. It's the time for good spicy odors from mother's kitchen as she does the fall canning. It's the time for popping corn over a crackling fire.

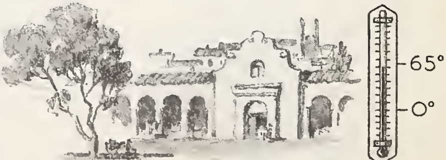
Long days and short days, warm days and cold days—aren't they fun?

Hot and Cold Days

Did you ever stop to think how much longer we have light on a summer day than on a winter day?



New York



Mexico City

Summer Days

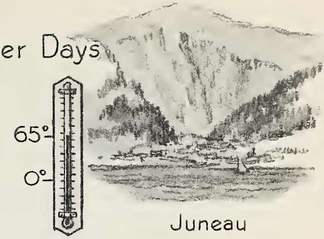
How early the sun comes up! The bright sunlight shines in our bedroom and wakes us before six-thirty. Twilight doesn't come until late in the evening.

No wonder summer days are warm. The sun's light and heat warm the place where you live for sometimes as long as fifteen hours.

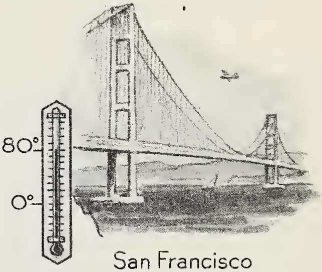
A winter day is quite different. It may still be dark when you get up and dress for breakfast. The sun's light may not begin to shine on the place where you live until eight o'clock.

Twilight comes early. By bedtime, it's cold and dark. The sun has been shining only nine or ten hours. If you live in such a place, no wonder it is not very warm in winter.

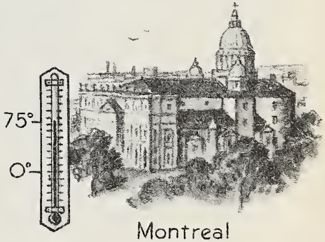
So, in many places on the earth, summer and winter days are usually very different in temperature. The long, long summer days are warmer. The short winter days are colder.



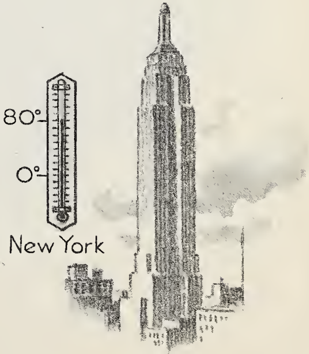
Juneau



San Francisco



Montreal



New York

Mexico City

On a winter day in Juneau, Alaska, it may be 40 degrees below zero. On the same day it may be 60 degrees in San Francisco, 12 degrees in Montreal, and 45 degrees in New York City. At the same time, in Mexico City the temperature may be 65 degrees. However, each place is having its winter season.

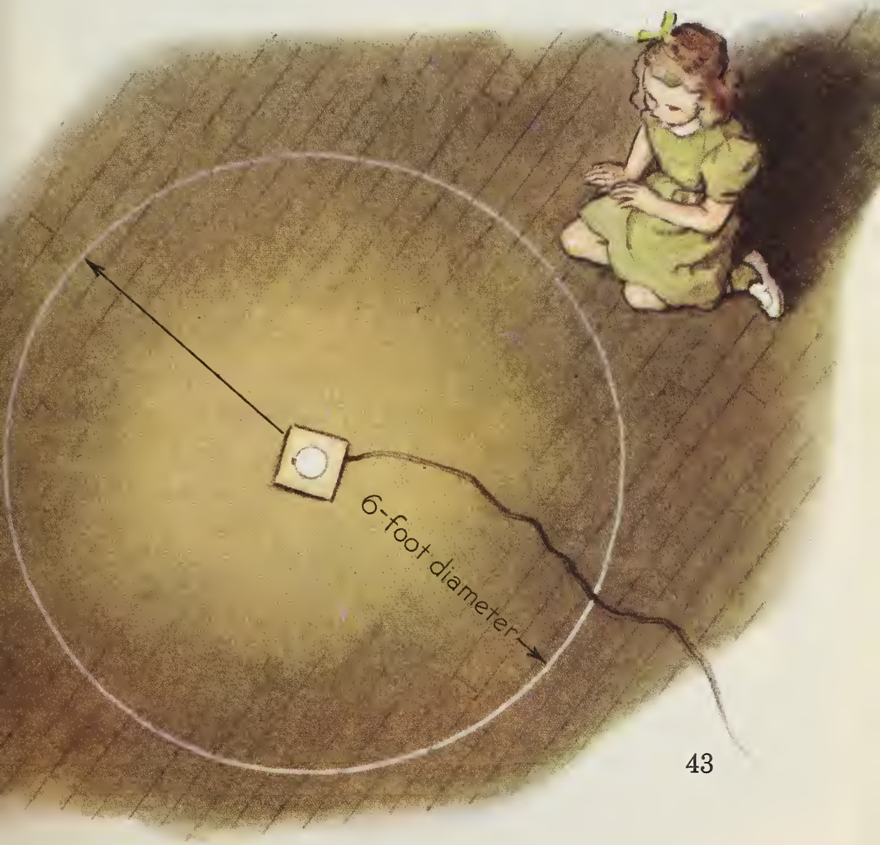
What would you guess about the summer temperatures in these same cities? Of course they are higher. The temperature may be 65 degrees in Juneau, 80 degrees in San Francisco, 75 degrees in Montreal, 80 degrees in New York City, and 70 degrees in Mexico City. All these places are having summer.

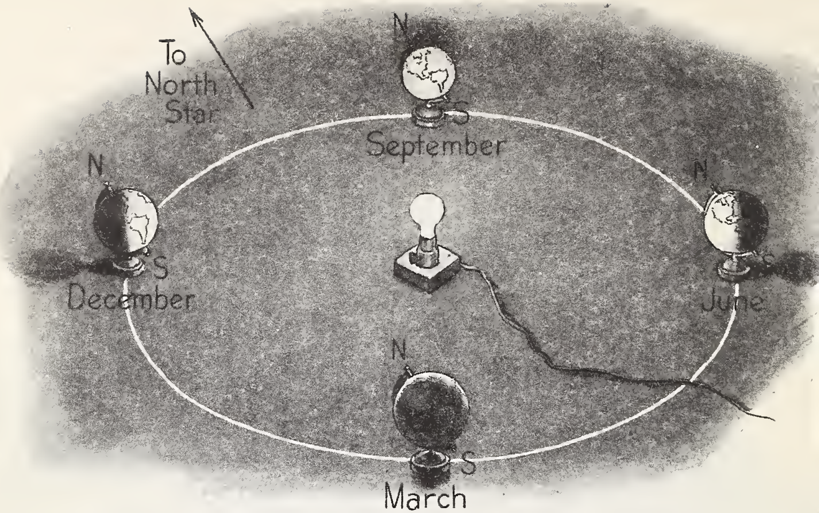
Wouldn't you describe summer and winter as seasons of hotness and coldness? Most of us do. Heat must have something to do with seasons.

Why the Seasons Change

Should you like to know why the days are shorter and colder in winter and longer and warmer in summer? Then you might like to try this experiment.

Draw on the floor a circle with a diameter of about six feet. Put a bright light in the center of this circle. You may use a very strong flashlight, a low lamp, or three or four candles. The bright light represents the sun. The circle represents the path of the earth around the sun.





Now place four small earth globes on the circle, in the way shown above.

The north pole of each globe should point toward the north side of the room. Now you are ready to darken the room and turn on the light in the circle.

We have drawn the path of the earth around the sun as a circle. This is not exactly right. If we wished to be absolutely correct, we should have to let the earth come a little nearer to the sun in December.

You and I never notice that we are nearer the sun in December, because we are so very far away from the sun all the time. Doesn't it seem strange that December days are among our coldest days, though the earth is nearest the sun at this time?

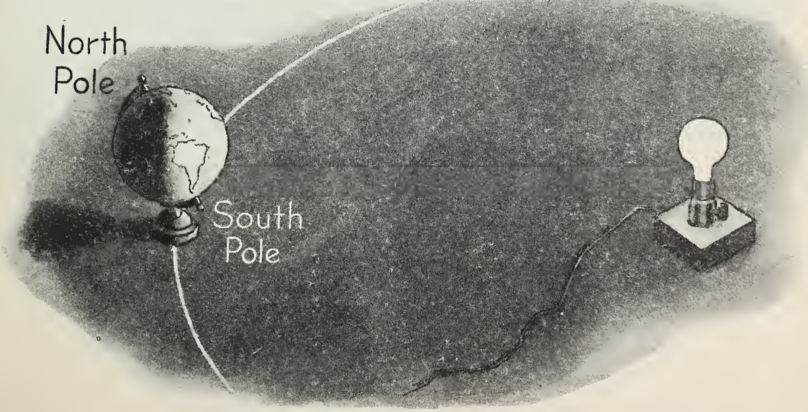
So now we know that it is not the changing distance between the earth and the sun that causes the change in seasons. If it were, the winter months would be our warmest months because the earth is nearer the sun at that time.

December in North and South America

Let's look again for a reason for our short winter days and our long summer days. In your experiment you see that the north pole of each globe is pointing in the same direction. No matter what day of the year it is, the north pole is always pointing in the same direction.

The north pole of the earth is always pointing toward the North Star. This means that the earth is tilted on its axis. Because of this tilting, some parts of the earth receive more light and heat during December than other parts.

This picture shows the way sunlight falls on the earth in December:



Though the earth is turning round and round on its axis, the north pole is not lighted during December days and nights. This is the time of long, cold nights in the arctic regions. And this is the time of our winter days in North America.

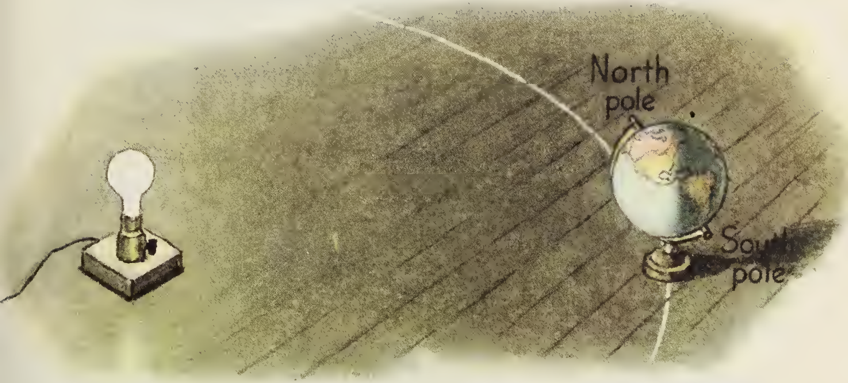
But what is happening in South America during December? As you turn a globe, notice how long the sunlight falls on South America.

Look at the south pole. The sun lights the south pole all day and all night in December. This is the warmest season of the year in the countries south of the equator. December is the beginning of summertime in South America!

Here is a picture of some children in the South American country called Argentina. Isn't it strange to think of Christmas Day as such a bright, sunny summer day that children can go swimming?

You know that the summer season in North America comes a few months after the winter season. This means that the earth has traveled half way round the sun. The north pole of the earth is still pointing to the North Star. But now a different part of the earth is having long, sunny summer days.

This picture shows the way sunlight falls on the earth in June:



How interesting it would be to visit the arctic regions during June! If you were there, you would say you were in "the Land of the Midnight Sun." The sun shines all day and all night during part of the summer in the arctic regions.

All the earth north of the equator is having summer. Place a globe in the same position as the one on page 47. You can see, when you turn the globe on its axis, that the countries in the northern part of the earth are having long days and short nights.

In North America the June, July, and August days are warmer than the December and January days. Do you know why? The sun shines for a long time each day on North America during June. The sun shines on North America during December days too, but it shines for a much shorter time each day.

Can you tell by looking again at your globe what is happening south of the equator? You will see that the south pole is in complete darkness day and night. Very little sunlight falls on the south-polar region during June and July.

Have you discovered what is happening in South America during June and July?

Yes, South America is the land of June and July winters. It is colder in South America during these months because that part of the earth receives less light and heat than it does during December.

If you should visit the high plains of Argentina during June, July, and August, you might see some of the things you see in the picture below. This is a cattle-raising country. It is not too cold for the cattle to be out of doors. But you would see the people wearing warm clothing. You might even see snow on the ground.

Wouldn't it seem strange to have snow on the Fourth of July?

The In-Between Seasons

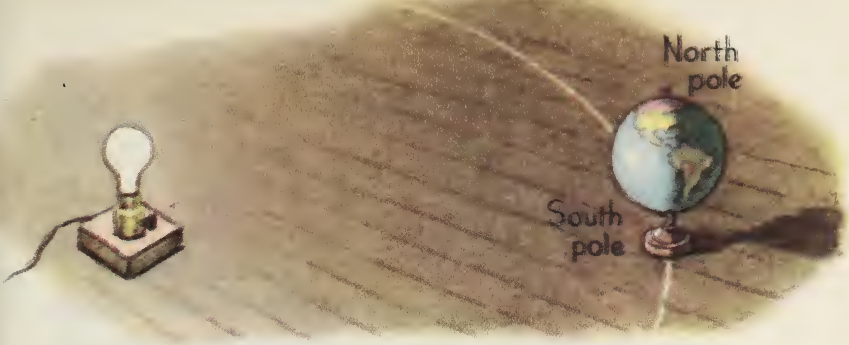
Spring and fall might be called the in-between seasons. Spring days are the days between cold, short winter days and long, sunny summer days. Fall days are the days between warm, long summer days and short, cold winter days.

You know the names of the fall and spring months in North America. In South America the seasons are turned around. The South American spring months are our fall months. Then, of course, the South American fall months are our spring months.

	North America	South America
Fall months	September October November	March April May
Spring months	March April May	September October November

The picture on the next page shows the way the earth looks in September. The day side of the earth is lighted by the sun.

Place an earth globe and a light on the table or on the floor so that the light falls on the globe just as it does in the picture. Find the place on the earth where you live.



Now turn the earth on its axis. Is the night longer than the day? No, the days and nights are almost of equal length. This is true of every place on the earth at this time of the year.

During September the sun's rays shine almost directly on the equator. For this reason it is very hot at the equator. And for this same reason, a place about a thousand miles north of the equator receives from the sun about the same amount of light and heat as a place a thousand miles south of the equator.

September days north of the equator are long, warm, hazy days. The leaves begin to turn red and yellow. Soon they begin to fall. Winter is on the way.

September days south of the equator are long, warm, sunny days. The tiny green leaves begin to appear on the trees. Flowers begin to bloom. The days grow warmer. Summer is on the way.

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Now let a globe travel half way around the sun. It is now the month of March. You probably know that in March the days and nights are again of almost equal length. Again the sun's rays shine almost directly on the equator. It is very warm there.

March in North America brings the warm spring days. But March in South America brings the snappy fall days. Each place has the in-between seasons, but at exactly opposite times of the year.

Wouldn't it be fun to travel to South America in September to enjoy the spring there? You could stay for the summer season. Then you could travel to North America in March for the spring and summer. If you did this, you would always be living in a "land of spring and summer sunshine."

Seasons Change Everywhere

Seasons change all over the world. The days grow longer and shorter. The nights grow longer and shorter. Summer days and nights are warmer than winter days and nights.

Do you understand why seasons change all over the earth? It is because of the tilting of the earth on its axis. The earth is always tilted toward the North Star. At one time of the year the part of the earth north of the equator receives a great deal of heat. Then the northern part of the earth has its summer. The southern part of the earth receives less heat; so that part of the earth has winter.

Summer days do not have the same temperature all over the earth. Winter days are colder in some places than in other places. But all places on the earth have some kind of seasonal change.

SOMETHING FOR YOU

1. Suppose you wanted to live in cool fall and winter weather all year long. How would you travel about on the earth to do this?

2. A certain part of the earth receives more light and heat from the sun all during the year than any other part. Which part of the earth is it?

3. The number of the daylight hours changes each day. You might like to keep a chart like this one to see what happens each day. If it is spring, the number of daylight hours will be more and more. If it is fall, the number will be less and less. You may not be awake when the sun rises. If you aren't, you can get the information from your daily paper.

Day	Sun Rises	Sun Sets	Number of Daylight Hours

Plants Through the Seasons

New Plants from Old

Look out of your windows at the trees and other plants. How have they changed since school began?

If it is fall or winter now, some of the trees have lost their leaves. Flowering plants have stopped blooming.

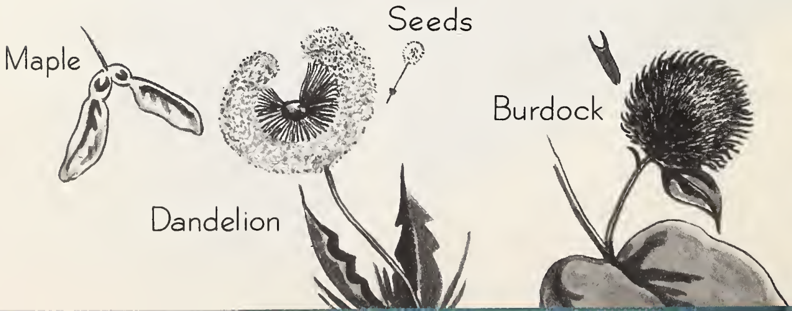
Some plants have died. Others seem to be dead. Do you know what caused these changes in the plants?

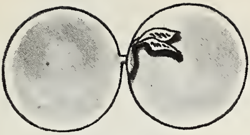
Some plants die as winter comes. We pull these dead plants up from our gardens and burn them. The farmer plows some of his dead plants under so that they are covered with soil. The dead plants help to make the soil richer.

Yet the next spring there are always more of these plants. This is because the plants produce, or make, seeds before they die. The farmer gathers seeds in the summer or fall and plants these seeds in the spring. Sometimes seeds fall from plants and lie in the soil until the next spring. In the spring they begin to grow into new plants.

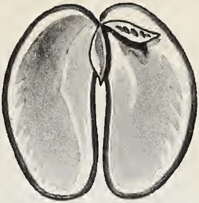
Each seed is made up of a small plant and of food for the small plant.

Some seeds have wings. Winged seeds are easily blown about by the wind. Other seeds have hooks. These hooked seeds are caught in the coats of animals and are scattered. Perhaps you know of other seed coverings which help in the scattering of seeds. Have you ever seen small seeds with long, white fuzzy threads? Of what use are these soft, white threads?


Seeds



Pea seed



Lima-bean seed

In the spring these seeds grow into new plants. The small plant lived all winter inside the seed. It was well protected. The food material stored in the seed helps the young plant to grow rapidly in the warm spring.

If you would like to see one of these small plants, try this experiment. First soak some dried Lima beans or some dried peas overnight.

The next day open the bean or pea seeds. They will be soft enough so that you can pull them apart easily. Do you see the small plant in one end of each seed?

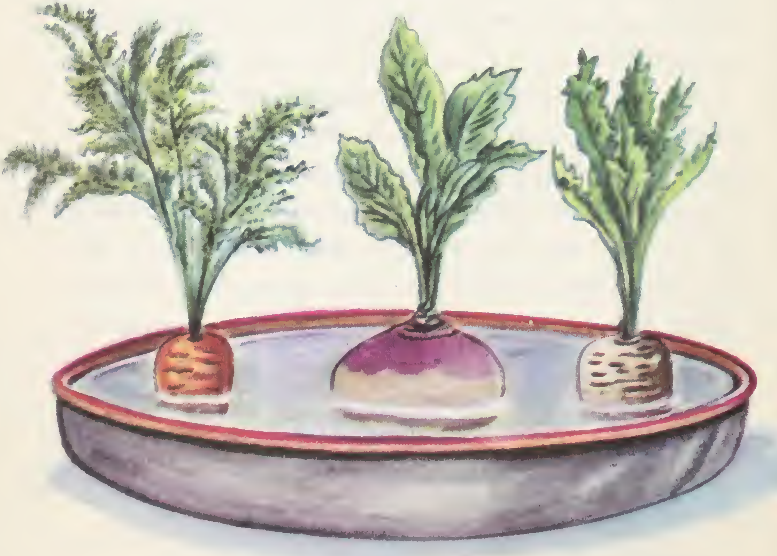
All the rest of the seed is stored food. The small plant in the seed is able to live over the winter months. In the spring it uses the food as it grows.

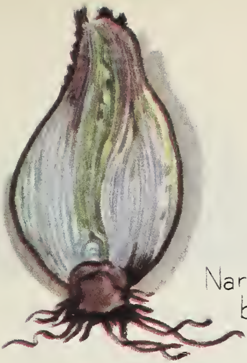
Some plants look as if they died when winter comes, but they don't really die. Their leaves die and fall. Their stems die. But their roots live all through the winter. These roots are storehouses of food. The plant uses this food as it begins to grow in the spring.

Should you like to see that roots can grow? If you would, get a plate or a shallow pan, such as a pie tin. You will also need two or three roots, such as carrots and turnips.

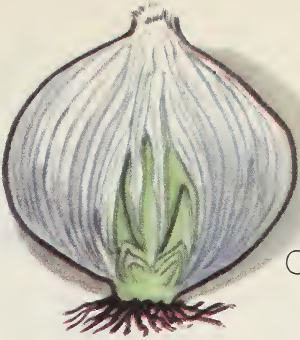
Put a little water in the plate. Cut the tops off the carrots and turnips. Place the tops in the water. In a few days tiny green leaves will appear. Do the leaves growing from each kind of the root tops look different? You can tell that they are different plants.

The young plants get their food from the old roots. After a while the tiny green leaves make their own food. You must be sure to keep water in the plate, since leaves need water to make their food.





Narcissus bulb



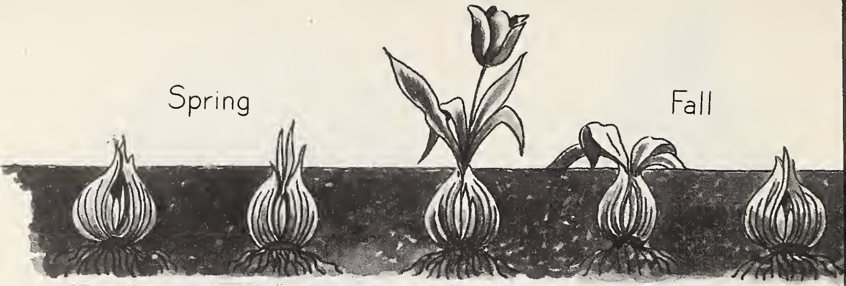
Onion bulb

Some kinds of plants live through the cold winter months as bulbs. You have eaten bulbs when you have eaten onions. You planted bulbs when you planted tulip or narcissus bulbs.

Perhaps you have wondered how a narcissus bulb can grow in a bowl of pebbles and water. The reason is that there is a young plant in the center of the bulb. This plant is surrounded by food material. So, when the bulb begins to grow, it uses this stored food material.

If you cut a narcissus bulb in half the long way, you can see the young narcissus plant surrounded by food material. If you cut an onion bulb in half, you can see the young onion plant surrounded by food material.

Plants which produce bulbs begin to grow in the spring. At first they use the food which has been stored around them in the bulb.



As soon as green leaves appear, these leaves begin to make food for the young plant. After a while the leaves will have made so much food that some of it is stored at the base of the plant. This stored food will become part of a new bulb.

Bulbs grow during the summer. By the time the cool fall days come, food material for the next spring's growth is stored in the bulb.

Spring Buds

Suddenly, on a warm day in the spring, tiny green leaves will appear on many trees and bushes. These leaves have been on the trees all winter. You have not seen them, because they have been hidden away in buds. The small, tender green leaves have been protected from the cold winter weather.

These buds were formed during the warm summer growing season. Inside each bud a tiny, green leaf is folded. Get a small twig from a tree sometime during the winter or early spring. Do you see the buds?

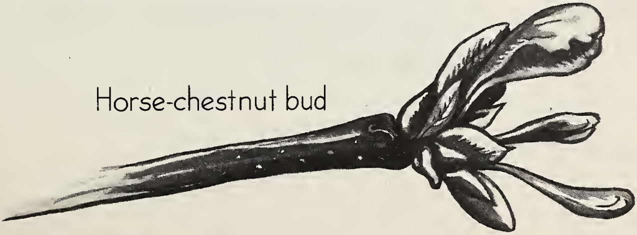
Pull one of the buds apart very gently. Inside you will find the tiny, curled leaves. Are they a greenish color? The picture at the bottom of the page shows a horse-chestnut bud pulled apart.

Isn't it strange to think of leaves staying on a peach tree or an elm tree all winter? You can't see these leaves, but they are there just the same.

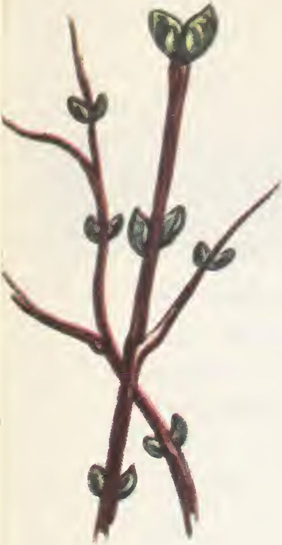
Perhaps you would like to collect small twigs or branches from several different kinds of trees and bushes. You must cut each twig carefully with a sharp knife. If you tear a twig off a tree or bush, you may injure the plant. Collect only one twig from each bush or tree.

Pull one of the buds on each twig apart very carefully. Does each of the buds have tiny leaves folded inside it? Notice how well protected these leaves are.

Try to take one of the buds apart so carefully that you can unfold one of the tiny leaves. Spread it out on a piece of paper. Does it look like the large leaves of the same tree? It probably has much the same shape. It has tiny veins placed in the same way. It looks just like a full-grown leaf, except that it is smaller and not quite so green.



Horse-chestnut bud



Lilac buds

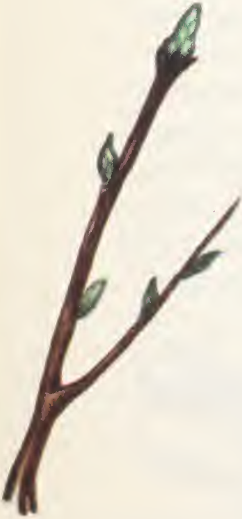
Now take another look at each of the twigs which you have collected. Are the buds on each twig arranged in exactly the same way?

You will probably find that some of the buds are opposite each other on the same branch. This is the way in which lilac buds are arranged on the branch. Which of your twigs have buds opposite each other?

Other buds form a spiral around the branch. This is true of the leaf buds of the cherry tree. The buds are one above the other, but on different sides of the branch. Which of your twigs have buds arranged in this way?

Twigs and small branches make beautiful winter or early spring bouquets. Try to arrange them so that you can see the lovely outline of the buds.

If you collect these twigs during the winter or in the early spring and place them in water, you will find that the buds will open. Of course you would not expect all the buds of the different twigs to open on the same day.



Cherry buds

When the buds begin to open, you may have quite a surprise! Not all the buds of your bouquets are leaf buds. Some of the buds are flower buds.

Open some of the other buds very gently to see if they are flower buds. Do you see the tiny, folded petals? Flowers have been on the trees and bushes all winter, too! These flower buds were formed during the warm summer.

If you have the twig of a pear tree, the flowers will be white. Peach-tree flowers will be pink. Flowers of the maples will be greenish-yellow.

The flower buds usually open first. Then the leaf buds open. First there is a cloud of pink or white or yellow blossoms. Then the tiny green leaves unfold from other buds. How beautiful your tree bouquets have become!

The trees and bushes which looked dead were not dead at all. Tiny flowers and leaves are on the trees all winter long. Each bud has its own leaf or blossom. As the warm spring days come, the trees and bushes burst into bloom.

Maple
blossoms

Peach
blossoms

Falling Leaves

Do you enjoy walking through the woods in the fall? Do you like to hear the dead leaves crackle as you step on them?

Or perhaps you like to walk through a pine grove. You make very little noise as you walk along. The pine leaves, or "needles," make a soft carpet.

Many trees lose their leaves in the autumn. Maples, elms, willows, and other trees lose their leaves before winter comes.

Winter is not the time for tree growth in most parts of the world. There is too little sunlight and warmth. Much of the water in the soil becomes frozen so that roots cannot take it into the plant.

Trees grow a great deal during the spring and early summer. This is the time of the long days of the year. There is much light and warmth. The warm spring rains give the trees much water. Trees can take this water into their roots because the water is not frozen in the soil.

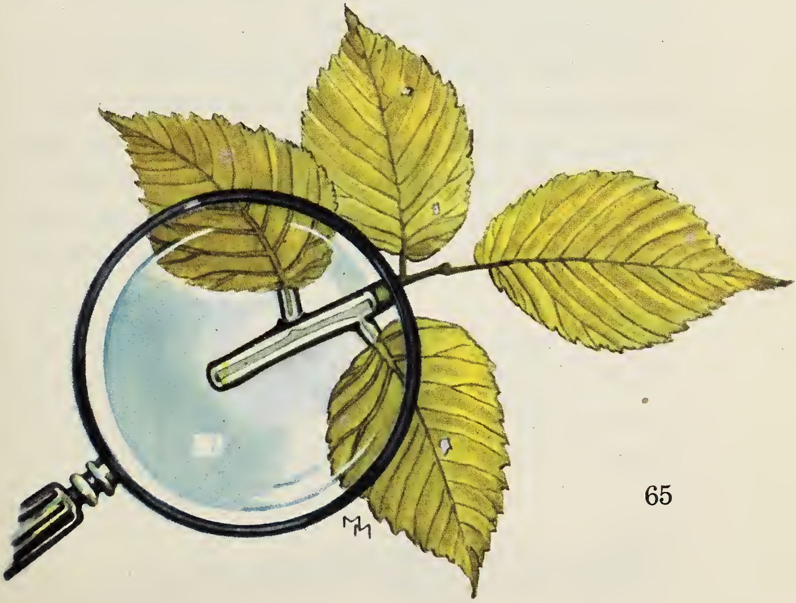
By about the middle of the summer the trees have grown as much as they will for the year. Some trees have grown taller. The leaf and flower buds have been formed. The trees and bushes have made food and stored food during the warm spring and summer.

Then autumn comes. The brightly colored leaves are blown off the trees very easily.

The reason leaves fall so easily in autumn is that a separation layer has formed. This separation layer is a kind of thin skin. It forms at the base of a leaf. That is, the separation layer grows between the leaf stem and the stem of the tree. A leaf falls when its separation layer is completely formed.

In the picture below there are four leaves growing on a twig. At the base of which leaf has a complete separation layer been formed?

It is not always easy to pull a green leaf from a tree. This is because the separation layer has not



been formed. After the separation layer is completely formed, a very gentle breeze will cause the leaf to fall.

There are never open wounds on tree branches after the leaves fall. This is because the separation layer protects the spot from which a leaf fell. This spot is called a scar. If you look at tree twigs in the autumn, you can see the leaf scars very easily.

Have you ever noticed that oak leaves often stay on the trees all winter? This is because the separation layers have not completely formed.

A heavy frost sometimes delays the falling of the leaves. Separation layers do not grow if it is too cold, and the leaves do not fall until the separation layers have been completed.

Evergreen leaves may fall at any time during the year except in cold weather. This is because separation layers may be completed at any other time of the year. Though evergreens have leaves during the winter, they do not grow then. Evergreens grow during the spring and summer, just as other trees do.

Do you see how seasons affect the growth of our plants? Plants grow well when there is light for food-making and when the water in the soil is not frozen. Plants do not grow well in cold weather.

SOMETHING FOR YOU

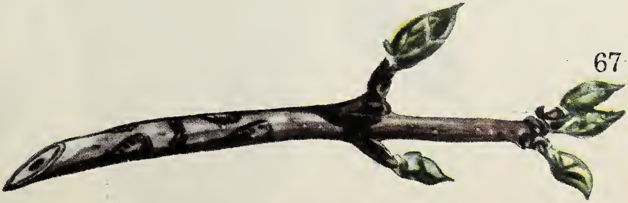
1. Here are some "Whys." Do you know the answers? Why do plants grow all year long in hot countries? Why do plants stop growing in most parts of North America during the winter? Why does your father wait until the danger of frost is past before he plants his garden? Why is it a good thing for us that food is stored in the roots, stems, leaves, and fruits of plants?

2. Choose four different trees near your school. Watch the trees in the fall to see which one loses its leaves first. Do any leaves stay on a tree all winter? Which tree has leaves first in the spring?

3. Choose one tree. Watch it from week to week in the spring to see when buds begin to form.

4. Plant about twelve young onion plants in a box of good rich earth which has plenty of dead leaves in it. Pull up one plant every week. Do you find that more and more food is being stored in the bulbs? Where is this food which is stored made? What finally happens to the leaves?

5. On the twig below try to tell which are leaf scars and which are buds.



Animals
Through the Seasons

Summer and Winter Coats

Do you have a dog or a cat for a pet? Have you noticed how thick and glossy its coat is in the fall? Does your pet's fur stay thick all winter?

Perhaps you remember how your cat or dog sheds hair during the spring and summer. Then, as cooler weather comes, new hair grows. The hair becomes longer, thicker, and shinier.

You may help your mother and father raise chickens or ducks. Have you noticed how the feathers of these birds fall out during the spring and summer? As autumn comes, new feathers grow. The winter coverings of chickens and ducks are thick and warm.

Do you live in a part of the country where many sheep are raised? Then you know that the sheep are sheared in the early spring. If the sheep-raiser waited until later, the sheep would have lost their thick winter coats.

Wild animals also lose some of their fur or feathers during the spring and summer. Bears, foxes, squirrels, and birds have heavy winter coats. Their summer coats are much thinner.

Thick, heavy coats of fur or feathers protect many animals during the cold winter months.

The coverings of some animals change in color, as well as thickness, during the year. The spring and summer coat of a robin is brighter than its winter coat.

Summer coats

Robin

Weasel

Persian cat

What other birds do you know that have bright summer coats? Do they have duller winter coats?

During the summer the fur of the arctic fox is blue-gray in color. When winter comes, the coat of this fox turns white.

A certain kind of weasel is trapped in the winter. This is because people who make coats of the fur of this weasel think the weasel's winter coat is more beautiful than its summer coat. The winter coat of the weasel is thick and white. It is called ermine. The summer covering of the weasel is thinner and quite different in color.

The winter coats of the arctic fox and the ermine make them difficult to see. This helps to protect these animals from their enemies.

Thick, heavy winter coats protect animals from the cold.

Animals do not plan to have different coats in winter. They are not able to think about new coats. But their coats do change as fall comes.

Winter coats

Robin

Weasel

Persian cat

Butterflies and Moths

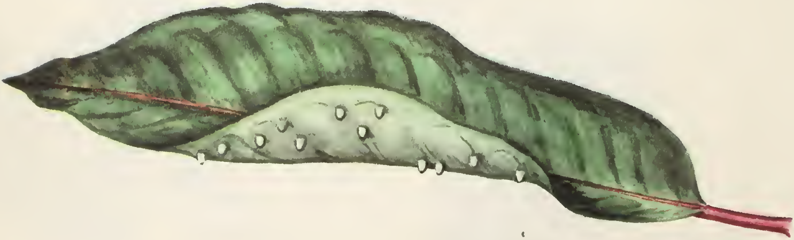
Have you ever seen butterflies and moths flying about in the winter? You certainly haven't if you live in a place where the winters are cold.

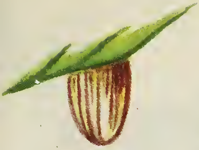
Many of our insects, such as butterflies and moths, are active in the summer. When winter comes, many die. But there are always more moths and butterflies the next summer. Do you know where they come from?

Moths and butterflies lay their eggs on the young green leaves of a plant. These eggs are laid during the early summer.

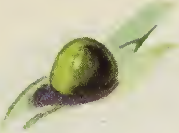
You may never have seen the eggs of a butterfly or a moth. They are very, very small. Some butterflies lay several eggs in one place. Then they are easier to see. But unless you were looking for moth and butterfly eggs, you probably wouldn't see them.

In the picture below are some monarch butterfly eggs on a milkweed leaf. The leaf and the eggs are shown in their natural size. How small each egg is!

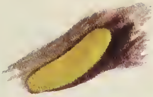




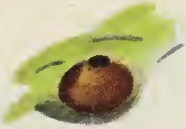
Monarch
butterfly egg



Yellow swallowtail
butterfly egg



Gypsy moth
egg



Cecropia moth
egg

Every kind of butterfly and moth lays a different kind of egg. The eggs of the Gypsy moth, the monarch butterfly, and the Cecropia moth all look very different from one another.

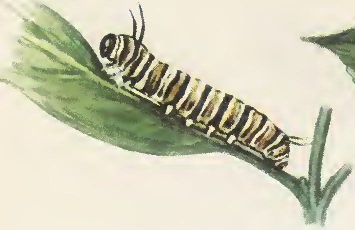
There are four eggs in the picture above. Each egg has been drawn so that it looks many, many times larger than it really is. How different the eggs are!

Most butterfly and moth eggs hatch a few days after they are laid. Do you know what comes out of the eggs? Yes, you're right — caterpillars.

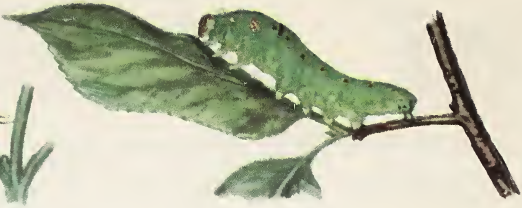
Caterpillars Change

The caterpillars of each kind of butterfly or moth look different from those of other kinds. However, in some ways all caterpillars are alike. They all have three pairs of legs near the head. And most caterpillars have five other pairs of legs.

Caterpillars eat and eat and eat. Their jaws are strong and are good for cutting and chewing. After a while a caterpillar becomes so fat that its skin splits



Monarch-butterfly caterpillar



Yellow-swallowtail-butterfly caterpillar

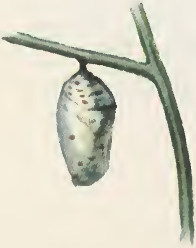
down the middle of the back. Then it crawls right out of its skin.

Again the caterpillar eats and eats and eats. It grows larger and larger. Again the skin splits. Again the caterpillar crawls out, and it continues to eat and eat and eat.

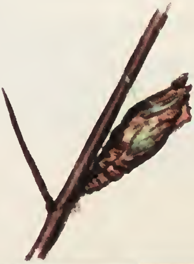
A caterpillar may shed its skin four or five times during the long, warm summer. The skin is shed because each time the caterpillar has grown larger.

As fall comes, another change takes place. The caterpillar has grown to its full size. It now begins to make a covering around itself.

Monarch-butterfly chrysalis



Yellow-swallowtail-butterfly chrysalis



Gypsy-moth caterpillar

Cecropia-moth caterpillar

Many kinds of moths make a covering called a cocoon. The covering of many butterflies is called a chrysalis. The cocoon or chrysalis is for protection.

A caterpillar makes a cocoon by spinning a long thread around itself. This thread is made of a liquid which comes from an opening in the body of the caterpillar. The liquid hardens when the air touches it. Chrysalises are sometimes made of leaves which are fastened around the body of the caterpillar.

A caterpillar does not eat or crawl about while it is in a cocoon or chrysalis. At this time the body of the caterpillar changes greatly.

Gypsy-moth chrysalis

Cecropia-moth cocoon

Monarch butterfly

Yellow-swallowtail butterfly

Each kind of moth caterpillar which spins a cocoon makes its own special kind of cocoon. Each kind of butterfly caterpillar which makes a chrysalis makes a different kind of chrysalis.

Some caterpillars do not make a cocoon or a chrysalis. These may burrow into the ground and make a small cave. Here they rest and wait for their bodies to change.

Some caterpillars stay in the chrysalis only two or three weeks. The butterfly which comes out of a chrysalis may live only until cold weather.

Most caterpillars stay in the cocoon all winter. In the spring they come out of the cocoon as full-grown moths.

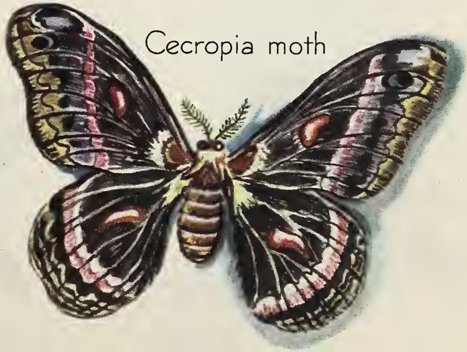
Have you ever seen a moth come out of its cocoon? If you would like to, take a walk through the woods and look for cocoons. You should do this in the autumn or winter, since you will probably be able to find more cocoons then.

You will find the cocoons hanging from trees or bushes. Keep a sharp watch for the cocoons. They look very much like dead leaves. When you do find a cocoon, cut the twig off the tree very carefully. Don't try to pull off the cocoon.

Perhaps you will keep your cocoons on the window sill outside your room. If you do, you will have to wait until late spring for the moths to appear.

If you keep the cocoons inside your room, the moths will probably come out sooner. This happens because it is warmer there. If your cocoons are inside the room, be sure to sprinkle them with water once or twice a week, or they may become so dry that the moths will die.

It is a wonderful sight to watch a beautiful moth crawl slowly out of its cocoon, dry its wings, and fly away.


Cecropia moth

Gypsy moth

Travels of Birds

Have you ever heard wild geese calling in the night? Have you ever seen a flock of birds following their leader? What time of the year was it? Yes, it was probably spring or fall.

These birds were traveling, or migrating, to their summer or winter homes. In the fall many birds migrate to the south. In the spring they migrate to the north.

Robins are among the first birds to fly north from their winter homes. When the first warm days come, these birds begin to migrate. When people see the first robins hunting worms on their lawns, they say, "Spring is here at last!"

Summer residents

Ruby-throated hummingbird

Bobolink

Baltimore oriole

Many birds begin to migrate in early April. By the end of May most of these birds have completed their spring migration.

These birds, which come early in the spring and spend the whole summer with us, are called summer residents. They build their nests and rear their young during the summer.

In the early fall many summer residents, such as the Baltimore orioles and the bobolinks, begin to migrate. They fly south long before cold weather comes.

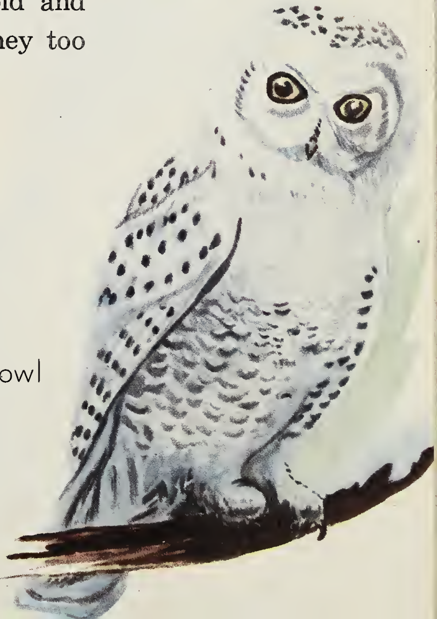
Many other birds stay in the north until the nights are fairly cold and food becomes scarce. Then they too fly south.

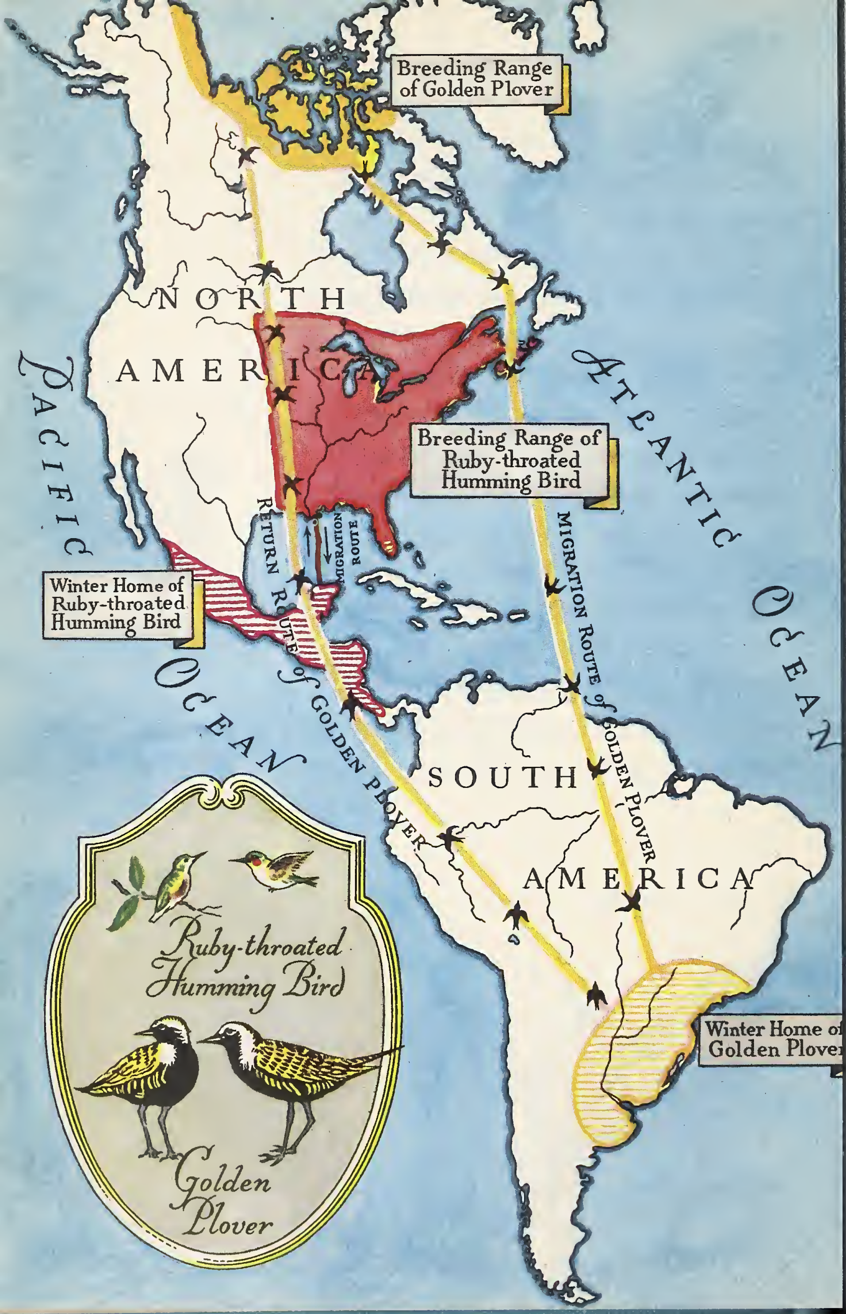
Winter residents

Tree sparrow

Pine grosbeak

Snowy owl




Breeding Range of Golden Plover
NORTH AMERICA
PACIFIC OCEAN
ATLANTIC OCEAN
Breeding Range of Ruby-throated Humming Bird
RETURN ROUTE
MIGRATION ROUTE
Winter Home of Ruby-throated Humming Bird
MIGRATION ROUTE of GOLDEN PLOVER
RETURN ROUTE of GOLDEN PLOVER
SOUTH AMERICA
Winter Home of
Golden Plove
Ruby-throated Humming Bird
Golden Plover

Juncos, tree sparrows, pine grosbeaks, and snowy owls are among the birds that spend the winter with us. We call them our winter residents. These birds spend the summer in the far, far north. There they build their nests and rear their young. In the winter they fly south to the United States.

Some birds are called permanent residents. You probably know many of these birds. Some of the most common ones are chickadees, nuthatches, and blue jays. These birds stay with us all year. They travel only short distances.

Among the greatest bird travelers are the hummingbirds. In the summer you see these beautifully colored little birds in your garden. They fly to a blossom to get the nectar. Then they quickly dart away to another blossom.

Look at the map on the opposite page. Follow the long journey of the hummingbirds on the map. They make this long trip each fall and spring.

Just think! These tiny birds fly all the way across the Gulf of Mexico. Their winter home is in Central America. In the spring they fly back across the Gulf of Mexico to the United States.

Another great bird traveler is the golden plover. This bird makes its nest and rears its young in the northern part of North America. Its winters are

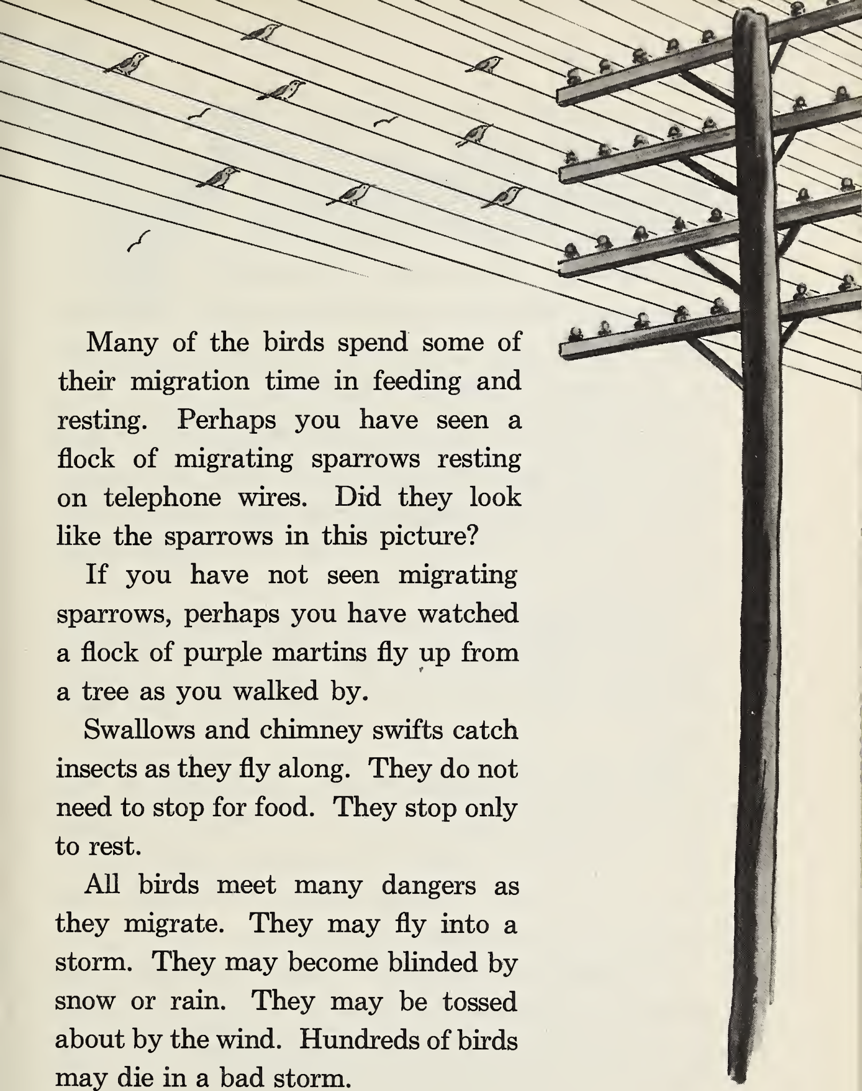
spent in South America. Look again at the map showing the journeys of the hummingbird and the golden plover. What a long, long journey the golden plover makes!

If you live in the mountains, you may have noticed that birds migrate up and down the mountainsides. In the summer they build their nests on the tops of the mountains. In the autumn when snow begins to fall on the mountaintops, these birds migrate. Their journey is a short one. They travel down into the valley.

Day and Night Travelers

Sometimes you see flocks of birds migrating. These are the day travelers. Many of the larger birds, such as the robins, bluebirds, and blackbirds, travel during the day.

Many of the smaller birds are shy and easily frightened. These birds usually live in the woods. Small birds have many enemies. It is a good thing that these birds travel at night. Wrens, sparrows, and orioles are among the night travelers.



Many of the birds spend some of their migration time in feeding and resting. Perhaps you have seen a flock of migrating sparrows resting on telephone wires. Did they look like the sparrows in this picture?

If you have not seen migrating sparrows, perhaps you have watched a flock of purple martins fly up from a tree as you walked by.

Swallows and chimney swifts catch insects as they fly along. They do not need to stop for food. They stop only to rest.

All birds meet many dangers as they migrate. They may fly into a storm. They may become blinded by snow or rain. They may be tossed about by the wind. Hundreds of birds may die in a bad storm.

Large birds may kill smaller, weaker birds for food. Other animals catch and kill the birds when they stop to rest and feed.

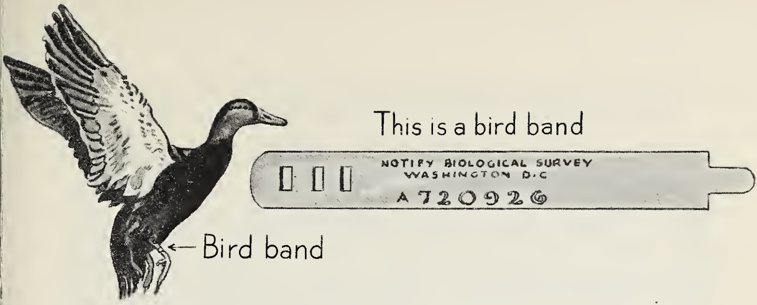
Perhaps you are wondering how fast these migrating birds fly. When birds first begin to migrate in the spring, they may travel only a few miles each day. The weather grows warmer. The bad storms are over. Then the birds travel faster.

Birds do not always travel the same distance each day. Sometimes robins travel only eight or ten miles a day. Sometimes they travel seventeen miles a day. They have been known to travel over seventy miles in one day.

Some birds fly at a speed of over a hundred miles an hour. Though these birds travel only a few hours each day, they can cover long distances in a short time.

The wind may help a bird to fly faster. The wind may also cause it to fly more slowly. Is it easy for you to walk rapidly when a strong wind is blowing in your face? Imagine how hard it would be for a bird to fly into such a strong wind.

Scientists have learned a great deal about the migration of birds by banding them. This means that they put a light metal band on a bird's leg. The bands are loose so that the birds will not be hurt.



Other scientists along the migration route trap a few of the migrating birds. They can tell about how long it has taken the bird to travel a certain distance because the place where the bird began its travels and the date when it began are told in the number on the band.

Of course the birds are not harmed when they are trapped. As soon as the scientist reads the place and date on the band, he sets the bird free. Then it can continue its journey.

Not everyone is allowed to band birds. Permission to band birds must be given to you by the government of the country in which you live.

The "Whys" of Bird Migration

Perhaps you are thinking, "Yes, I know birds migrate, but *why* do they migrate?" That is a most puzzling question. No one has yet been able to answer it, although many scientists have been trying a long time.

You may say that birds migrate to get food. Yet many birds begin to fly south while there is still plenty of food in the north. And even when the food in the north does become scarce and snow-covered, the birds do not need to fly as far south as they do to find food. They could find plenty of food in southern Florida or southern Texas or in Mexico. So there must be another answer to our question.

Another explanation is this: A long, long time ago, perhaps all the birds lived in the warm south. At first there was plenty of food for all the birds. Then more and more young birds were hatched. There were a great many birds. It was hard to get food. Some of the birds may have traveled north to find a new home. They laid their eggs and raised their families in their new northern homes. When the young birds were able to fly, the birds flew south again. This may have become a habit.

Still another explanation has to do with the number of daylight hours. You know that there are fewer and fewer daylight hours as fall comes. Perhaps less light causes a change in the birds which makes them migrate.

Scientists spend many hours working on this puzzling question. Sometime someone may be able to find a better answer to it.

Other Spring and Fall Travelers

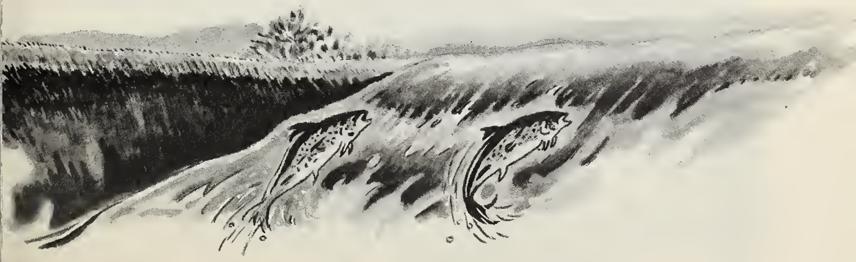
Fish Travelers

Have you ever visited the Bonneville Dam of the Columbia River? If you have, you may have seen the fish ladders at that dam. These ladders were built to help migrating fish.

Every spring a great many salmon swim up the Columbia River from the Pacific Ocean. Before the Bonneville Dam was built, the salmon could swim all the way up the river. Sometimes they had to swim against strong currents. Sometimes they had to leap over falls. But every year salmon migrated up the river.

Salmon can leap over falls as they swim upstream. But they can't leap over a high dam. So the fish ladders had to be built.

These fish ladders are a series of man-made pools. Each pool is higher than the last. The salmon leap from the river into the first pool. They swim about there for a while. Then they leap into the next pool. They leap from pool to pool until they reach the lake behind the dam.

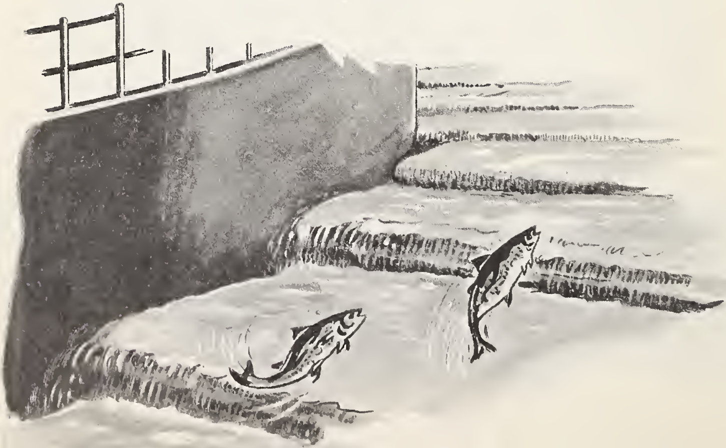


Perhaps the picture below will help you to understand how the fish ladders of the Bonneville Dam help the migrating salmon.

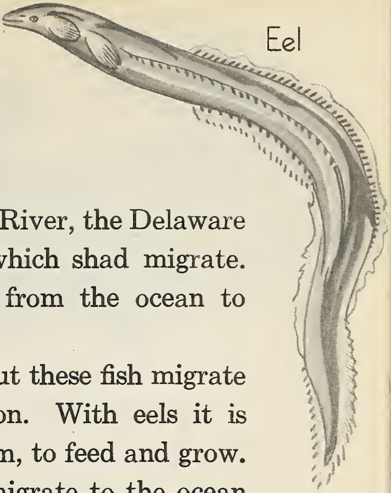
You may be wondering why salmon migrate up the Columbia River each year. They do this to lay their eggs. Salmon eggs are laid in the gravel and sand on the bottom of the streams which flow together to make up this great river. These eggs hatch into baby salmon.

When the baby salmon are six or seven inches long, they migrate down the river to the ocean. Here they feed and grow larger. After a few years they are ready to migrate up the river to lay their eggs.

Most salmon migrate only twice during their lifetime. They migrate to the ocean when they are young. When the salmon are full-grown, they travel up the river to lay their eggs. This journey upstream is so difficult that the salmon die after the eggs are laid.



Shad



Eel

You may live near the Hudson River, the Delaware River, or some other river up which shad migrate. These fish also swim upstream from the ocean to lay their eggs.

Eels are migrating fish also. But these fish migrate differently from shad and salmon. With eels it is the young fish that swim upstream, to feed and grow. When eels are full-grown, they migrate to the ocean to lay their eggs. The full-grown eels migrate in the autumn. The parent eels do not return from the ocean.

Other Travelers

Other animals migrate, too. Mountain sheep and goats usually spend the summer high on the mountainside. In the winter there is little food on the mountaintops. So the sheep and goats migrate down the mountain to find food and shelter.

Reindeer migrate each year. They spend the summer on the seacoast, feeding on the moss they find there. During the autumn and winter these animals travel inland to find moss. In the spring the reindeer travel back to the seacoast.

Polar bears migrate. In the summer they live on the loose ice far from shore. The ice travels southward during the summer and fall. The polar bears travel with the ice. When winter comes, the loose ice freezes into solid ice. It stays solid until summer comes. In the spring the bears travel northward over the solid ice in search of food.

Another migrator is the Alaskan fur seal. These seals swim far south to spend the winter in the warmer parts of the Pacific Ocean. They winter off the coast of California.

In the spring many of the seals swim north toward Alaska. Here, on islands in the Bering Sea, the young fur seals are born. The baby seals grow and grow during the summer. They become stronger and stronger. They are finally able to take care of themselves. In the autumn they swim south with the older seals.

Winter Sleepers

Most of you know what happens to frogs and toads in the winter. You often see them hopping about in the spring and summer. But they disappear in the winter. These animals do not migrate. They spend the winter sleeping.

This long winter sleep of some animals is called hibernation. Do you know some hibernators?

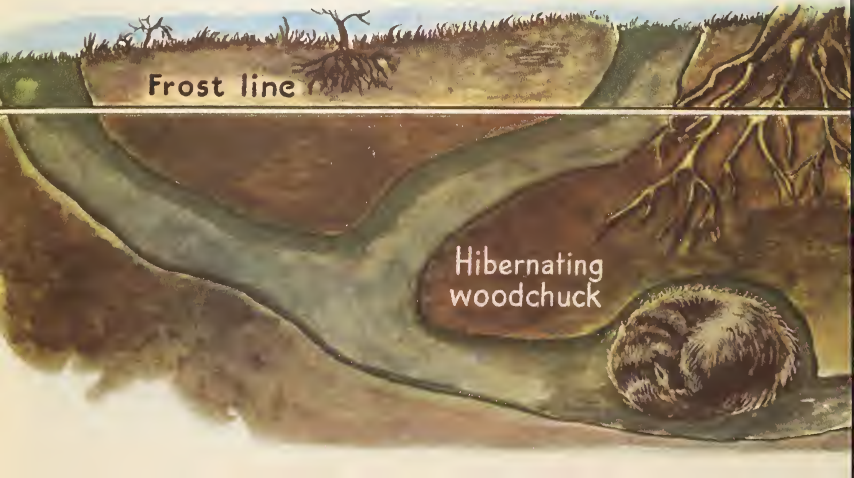
Frogs and toads find a place in the ground or in the mud at the bottom of a pond. Here they hibernate. Turtles also bury themselves in the sand and mud at the edge of ponds or streams.

Snakes find safe places under rocks and stones. They crawl into their homes in the late autumn or early winter. Here they hibernate until the warm, sunny days of spring. When it is warm enough, the snakes come out and hunt for food.

Have you thought about how frogs, toads, turtles, and snakes get their food during the long, cold winter? They do not eat at all during the winter. During the summer fat has been stored on their bodies. This fat is used up by their bodies during the winter. In the spring these animals are very, very hungry.

Some fur-bearing animals also hibernate. Woodchucks eat and eat all summer long. They store up layers of fat on their bodies. In the autumn they find a hole in which they will spend the winter.

Woodchucks do not come out and hunt for food during the winter. Their bodies use the food which has been stored as fat.



The bodies of hibernating animals change greatly during the winter. Their mouths and eyes are tightly closed. Their hearts beat slowly and feebly. Their breathing becomes very, very slow. They grow thinner and thinner. Some of these hibernating animals die. But many are able to live through the winter.

We don't really know why animals hibernate. Some scientists say that animals hibernate because they are not able to migrate. Neither can they find food all winter. So these animals spend the winter sleeping.

Many animals hibernate below the frost line. The woodchuck in the picture on the opposite page is hibernating deep enough in the ground so that it is below the frost line. This means that woodchucks and other animals that hibernate below the frost line are far enough down in the ground so that the blood in their bodies does not freeze. If their blood should freeze, they would die.

Partial Hibernators

Some animals are called partial hibernators. This means that they spend only a part of the winter in sleeping. Chipmunks, bears, bats, skunks, and raccoons are partial hibernators. On warm winter days some of these animals wake up and hunt for food.

Muskrats, meadow mice, squirrels, and opossums hibernate only when it is cold and stormy. Perhaps you have seen some of these animals hunting for food on sunny winter days.

Some of the partial hibernators, such as squirrels and chipmunks, store food for winter use. They gather nuts during the autumn. Then they eat these nuts during the winter.

Chipmunks often store their winter food supply in their underground homes. The storage rooms of these homes are below the frost line. So when the chipmunks go there for food and to sleep, the blood in their bodies does not freeze.

The seasons affect animals in different ways. The coats of some animals change color and grow heavier. Some animals migrate; some stay and hunt for food all winter. Others hibernate all or part of the winter.

SOMETHING FOR YOU

1. If it is fall, watch animals for changes. Do cats, dogs, cows, or horses seem to have heavier coats? Are squirrels storing food? Do you see other changes?

2. If it is spring, watch for changes. Are cats and dogs shedding their hair? Are chickens and ducks losing feathers? Are birds building nests? What other changes do you see?

3. If you would like to watch a hibernating animal, get a small turtle, frog, or garter snake. Keep it indoors in a screened box. Put some earth in the bottom of the box. Put some plants in the box to make it as much like the place where you found the animal as you can. As cold weather comes, place the box in a cool place. What does the animal do when it is cold? What does it do when the weather gets warmer?

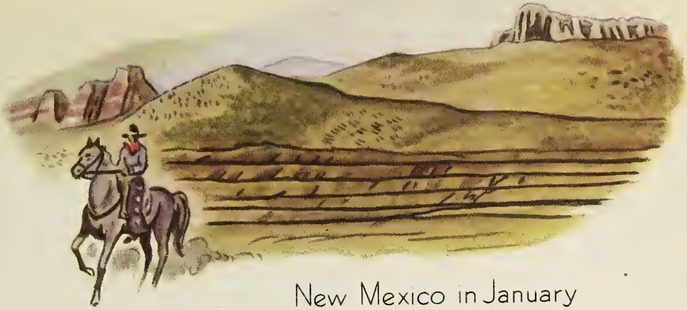
4. If you keep a bird chart like the one below, you may discover which birds migrate. If it is fall, you may notice the arrival of the winter residents. If it is spring, you may notice the arrival of the summer residents. Which birds stay all year ?

Bird	When Seen	Where Seen

What Makes Climates?

Vermont in January

Florida in January



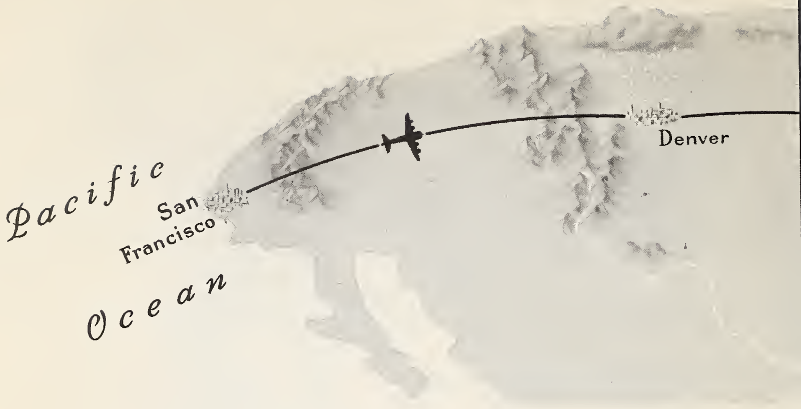
New Mexico in January

Oregon in January

Your Climate

Where do you live? Perhaps you live in Alabama. Perhaps you live in Wisconsin. Have you lived in the same place all your life? If you have, you have lived in one climate all your life.

Perhaps you have traveled from one climate to another. You may have been in both the north and the south in the winter.



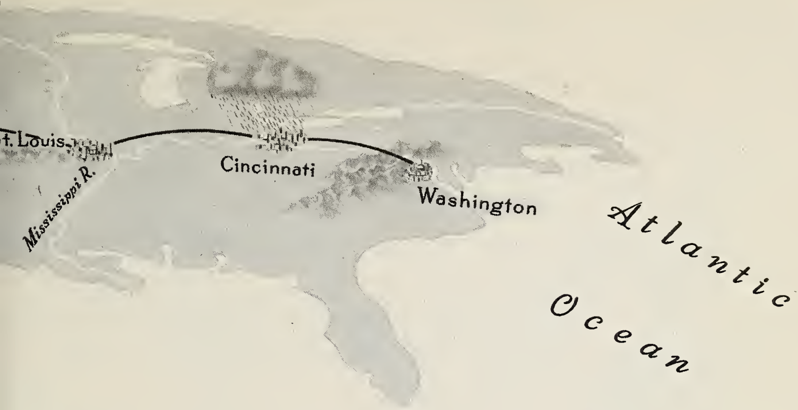
You probably wore a heavy snow suit in the north. Did you wear light coats and sweaters in the south? On some days you may have worn no coat at all.

A Trip from West to East

Let's take an imaginary airplane trip across the United States. We will fly from the west to the east. We will fly from San Francisco to Washington.

The time is January. It is a beautiful sunny day. The people at the airport wear light coats and jackets. Some wear hats; some do not. It is warm. A breeze is blowing from the Pacific.

Our plane takes off. We are beginning our trip to the East. We leave the Pacific Ocean. For a while we fly over fairly level land. Then our plane begins to climb. We go up and up.



Ahead of us we see snow-covered mountains. The land below us no longer looks green and brown. It is green and white. The brown earth is covered with snow. We are in a cold mountain climate.

Here and there in the mountains we see small villages. People come up into the mountains for winter sports. They can ski and ice-skate here.

Our plane is landing in Denver. In the summer it is warm here. But this is January, and it is cold in the mountains. People wear heavy clothing. There is snow on the ground. Children dressed in snow suits are enjoying sledding and skating.

We're going up again. As we travel eastward, we leave the high mountains behind us. The land is more level. There is less snow. In places there is no snow at all.

Ahead of us is a wide river. Yes, it's the Mississippi. Our plane is coming down again. We're in St. Louis. It is much warmer here than it was in Denver. But it is not as warm as it was in San Francisco. There are no warm Pacific winds to warm St. Louis.

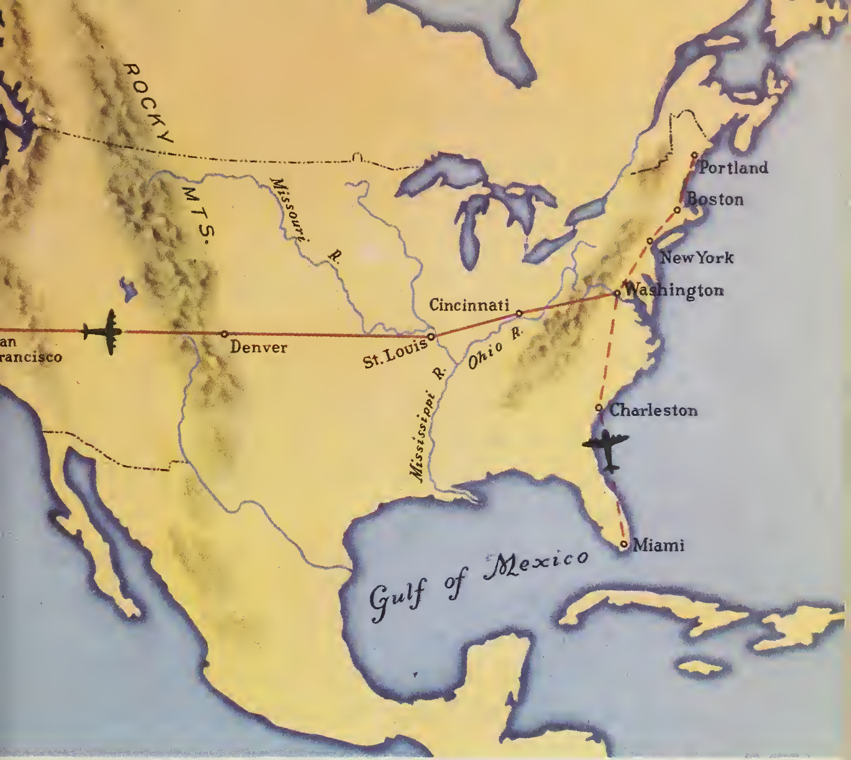
Our next stop will be Cincinnati. The pilot says that we shall fly through some bad weather. There are clouds ahead of us.

We take off again. Soon we are flying through clouds. Our pilot says this isn't a bad storm; so we fly on to Cincinnati. It's raining hard here. There is some snow on the ground, but the rain is melting it.

We're off again. This is the last part of our trip. Soon we leave the rain clouds behind us. Our plane climbs for a while. We're going over more mountains. These mountains are not so high as the Rockies, but there is snow here too.

We have left the mountains behind us. Now we are circling over the National Airport. There is the Potomac River below us. There are the Capitol and the Washington Monument.

The man in the control tower on the field has told our pilot to come in. We are circling lower and lower. Now we're landing. Our trip is over.



As we step out of the plane, we feel a bit chilly, but not cold. The weather is clear. There is no snow in Washington.

We have made a long trip, as you can see from the map. We have traveled almost straight across the United States from west to east. We have traveled through cold mountain climates and through warmer climates.

A Trip from South to North

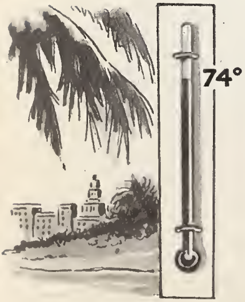
Suppose we could take a trip from Miami, Florida, to Portland, Maine. Perhaps you would like to follow this trip on the map on page 101. It is still January. We will fly over no mountains. We will fly along the seacoast all the way.

The temperature is 74 degrees in Miami. Our first stop is Charleston, South Carolina. The temperature is 62 degrees here. Do the pictures below help you to understand what happens as you fly north in the winter?

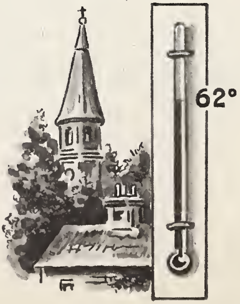
Yes, it gets colder and colder, even though we are not flying over mountains. What different climates Portland and Miami have!

Not all places in North America have the same climate. Some places may be warm most of the year. Florida and the southern parts of California and Texas have warm climates. Even during the winter months people enjoy swimming, sailing, and sun bathing there.

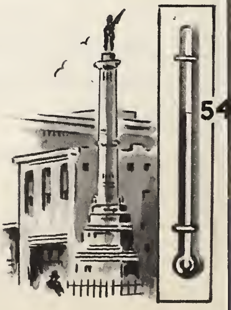
Miami



Charleston



Norfolk



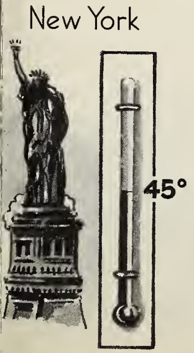
Some parts of North America may be cool all year long. Maine and Vermont, British Columbia and Quebec are such places. Many people come to spend their vacations in these places. The summers here are wonderfully cool. In the winter people come for winter sports. They ski, ice-skate, and take sleigh rides in the snow-covered hills and mountains.

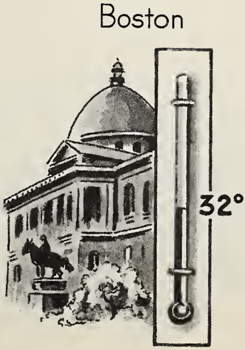
Cities in the mountains, cities on the plains, cities by the sea, cities in the north, cities in the south — all these places are in North America. What different climates they all have!

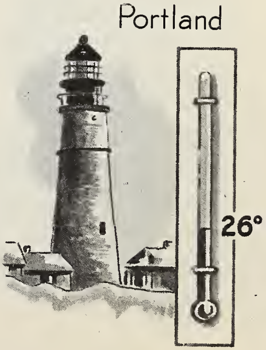
The Equator and Climates

Should you like to live near the equator? Some people do live there. What a warm climate these people live in!

The part of the earth near the equator is very warm all year long. This is because it always receives a great deal of the sun's light and heat.







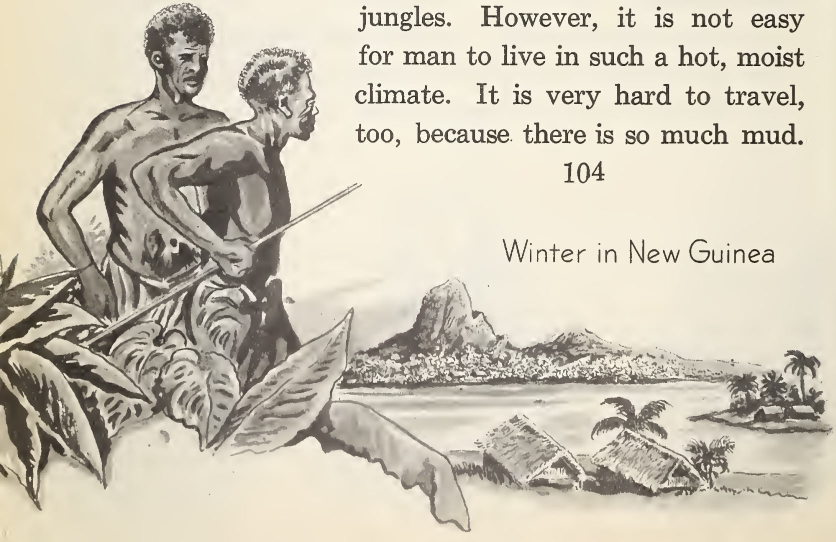
What are some of the hottest places you can think of? Did you name New Guinea or the Sahara Desert or the Amazon Valley in South America? Are you able to find these places on a world map?

You can see that these places are very near to the equator. Are they nearer to the equator than some of the other places you thought of?

New Guinea, the Sahara Desert, and parts of South America are warm all year long. Their winters may be a little cooler than their summers, but these places never have cold winters.

Some places have little rain. Such places are called deserts. It is difficult for man to live in desert regions. He has to depend on the outside world for much of his food.

Other hot places such as New Guinea have much rain. Plenty of food grows in the jungles. However, it is not easy for man to live in such a hot, moist climate. It is very hard to travel, too, because there is so much mud.



Winter in New Guinea

It is too hot to do very much work. There are a great many insects. You and I would probably be most uncomfortable in this climate.

Some places on the earth are cold all year. Do you see Greenland, northern Russia, and Antarctica on your world map?

As you can see, these places are far from the equator. They are either in the north-polar region or the south-polar region. The winters are long in these parts of the earth, and for many weeks the sun never rises. In the summer months the sun shines, but it is so low in the sky that it gives but little heat.

So far as we know, no one lives in Antarctica. Explorers have lived there for a while. But no one lives in Antarctica year after year. It is too cold.

People do live in northern Russia and in Greenland. The people who live there know how to build warm, snug homes. They know how to live in a cold climate.

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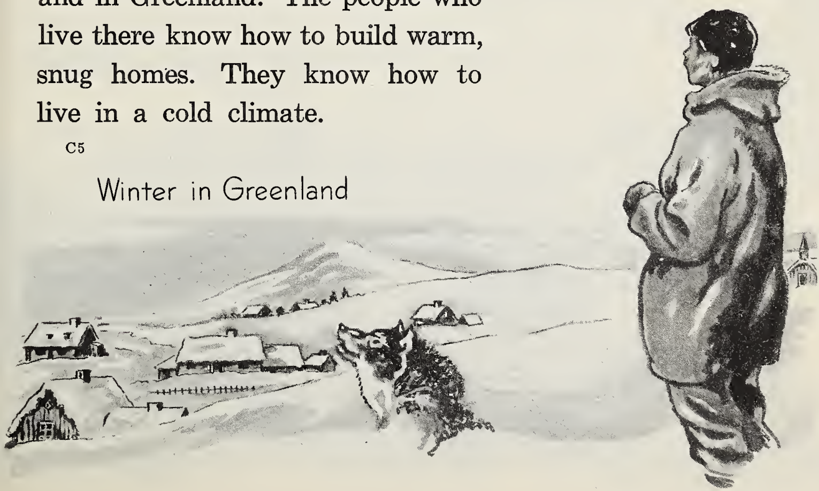


Winter in Greenland

In-Between Climates

Do you live in a place which is cold part of the year and warm part of the year? Then you probably live in the temperate zone.

This does not mean that your climate is cool, or temperate, all year long. It does not mean that the rainfall is equally scattered throughout the year. If you live in a temperate climate, then the place where you live is not hot all the time or cold all the time. Sometimes there is little rain; sometimes there is a great deal of rain.

If you live in this kind of climate, then yours is a temperate climate. It is an in-between climate.

Much of the United States and Canada has a temperate climate. The summers are warm, and the winters are colder. England, Germany, Japan, and much of Russia and China have temperate climates, too.

All these places are between the hot, tropical climates and the north-polar climates.

Could you think of some temperate climates which are between tropical and south-polar climates?

Did you name the southern parts of South America, Africa, and Australia? Did you name New Zealand? All these places have in-between, or temperate, climates.

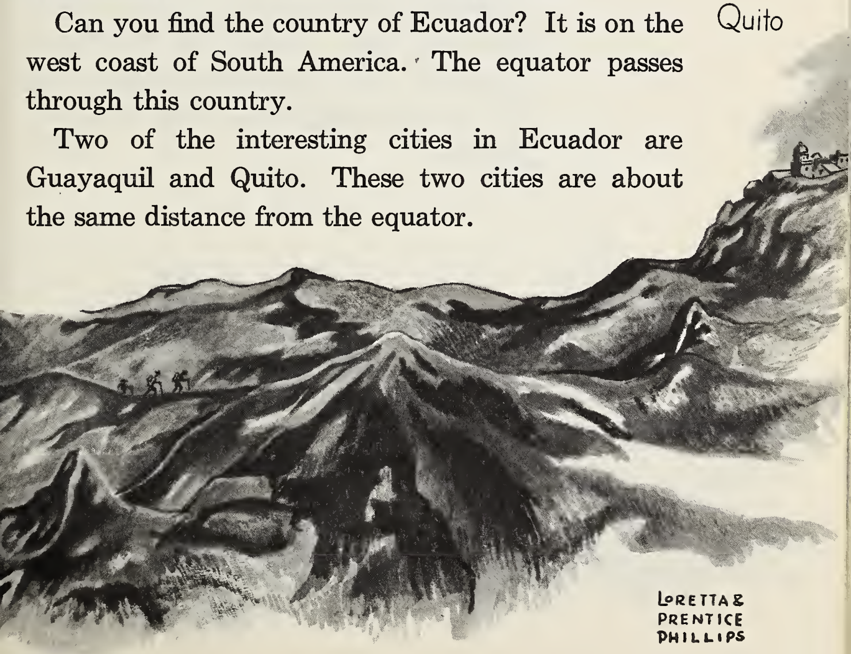
Mountain Climates

Many times people who live near the equator build their cities in the mountains. They do this in order to escape the great heat of the lowlands.

As you know, it is cooler on mountaintops because there is less air to hold the sun's heat. This is true of mountaintops anywhere on the earth. Even near the equator it is cool on mountaintops.

Can you find the country of Ecuador? It is on the west coast of South America. The equator passes through this country.

Two of the interesting cities in Ecuador are Guayaquil and Quito. These two cities are about the same distance from the equator.

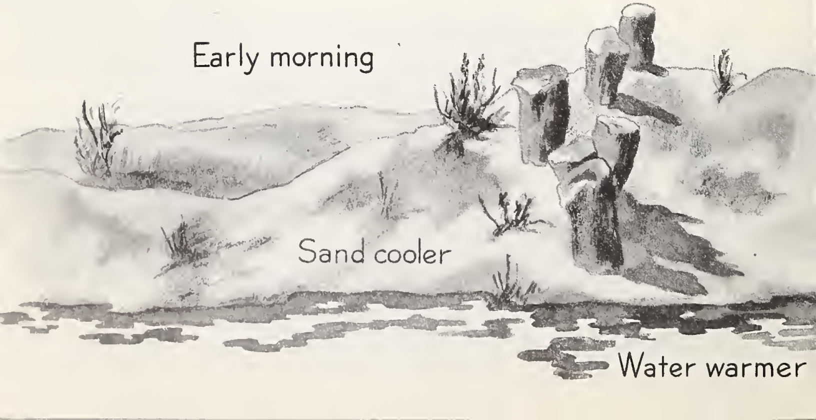


Yet the people of Ecuador say that Guayaquil has a very unhealthful climate. It is hot and moist. Quito's climate is more healthful. It is much cooler and drier.

Could you think why this is true? Yes, Quito is built on the top of a mountain. Guayaquil is built at the base of that same mountain.

Another mountain city which is fairly near the equator is Mexico City. You might think this city would have a hot climate, but it hasn't.

Mexico City is about a mile and a half above sea level. People who visit there say that it has a delightful climate. The city is cool, though it is fairly near the equator.

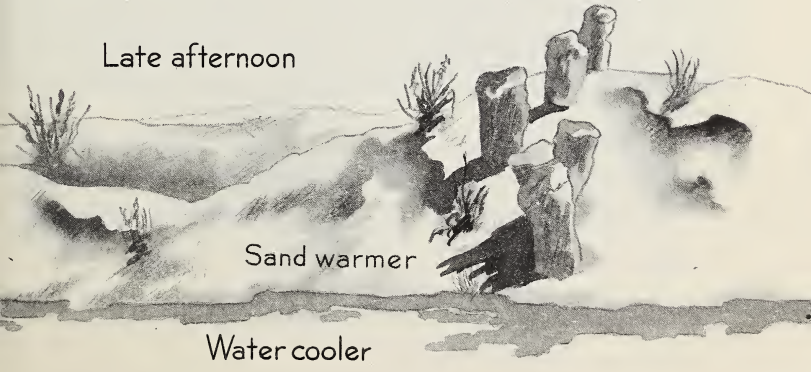


We can say, then, that the height of a city above sea level has a great deal to do with its climate.

Water and Climate

Have you ever walked barefoot on a beach early on a summer morning? The sand probably felt cool to your feet. When you stepped in the water, the water felt warmer than the sand.

If you walked along the beach later in the day, you may have noticed a difference in the heat of the sand. By noon, on a hot summer day, the sand often gets so hot that it burns your feet. Yet, if you step in the water, your feet feel cool.



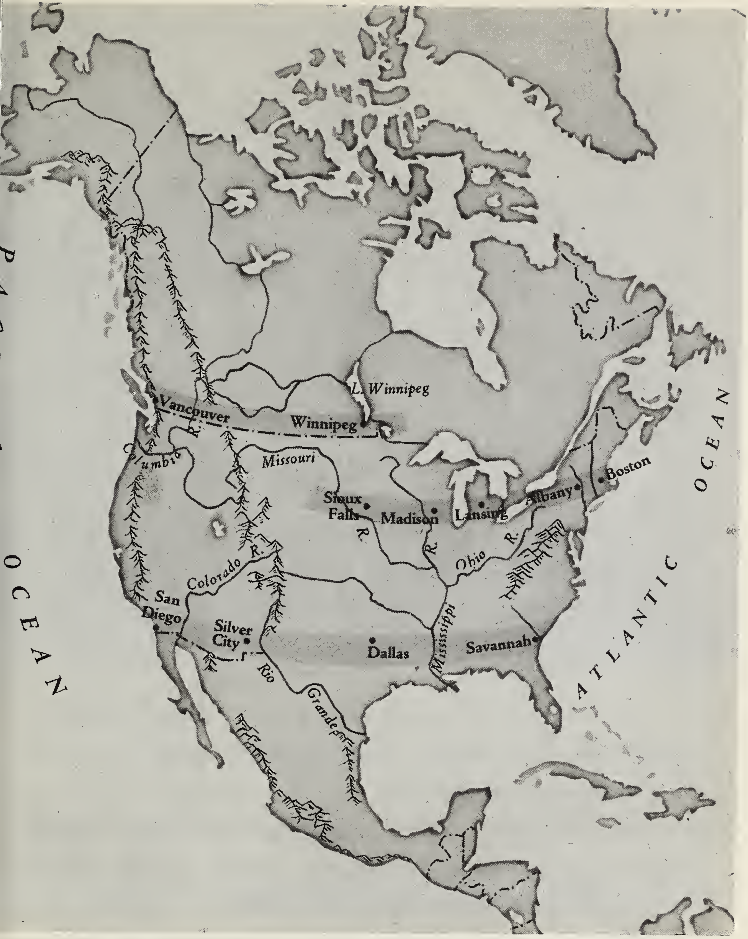
Scientists tell us that soil becomes heated much more quickly than water. But soil loses its heat more quickly than water, too. That is why, after dark or early in the morning, water feels warmer than the soil.

This fact about soil and water is not only true of daytime heat, but it is also true of summer heat. Both land and water take in a great deal of heat in the summer. But as winter comes, the land begins to lose its heat more quickly than the water. A large body of water, such as a lake or ocean, gives off heat into the air far, far into the winter months.

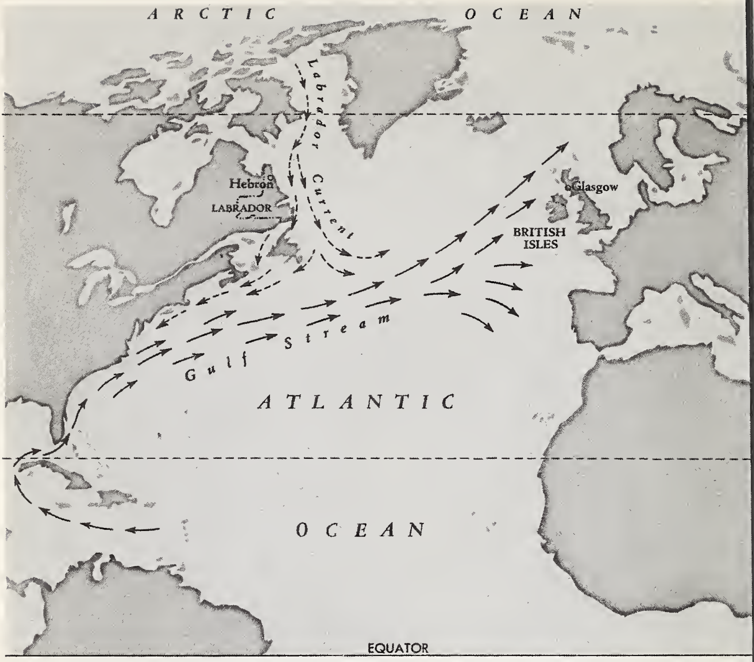
Do these facts help to tell you why a city near water does not have so cold a winter as a city far from a great river, lake, or ocean, even if the two cities are about the same distance from the equator? The inland city loses its heat rapidly in the winter. The coast city is warmer because of the warmer water which is near it all winter.

The inland city has a warmer summer than the coast city. This is because the land surrounding the inland city gains heat more quickly. The coast city has a cooler summer because the water heats much more slowly.

Here is a map of North America. The cities in each group are about the same distance from the



equator. None of the cities are high in the mountains. Which of the cities in each group have the hottest summers and the coldest winters? Why?



Have you ever heard how cold it is in Labrador? Eskimos live there. There aren't many cities in Labrador. It is too cold.

You probably know more about Great Britain than you do about Labrador. Many people live in Great Britain. The climate is mild.

There is a great difference between the climates of Labrador and Scotland, which is a part of Great Britain. Yet these two countries are the same distance from the equator.

The average yearly temperature of Glasgow, Scotland, is about 47 degrees. The average yearly temperature of Hebron, Labrador, is about 23 degrees.

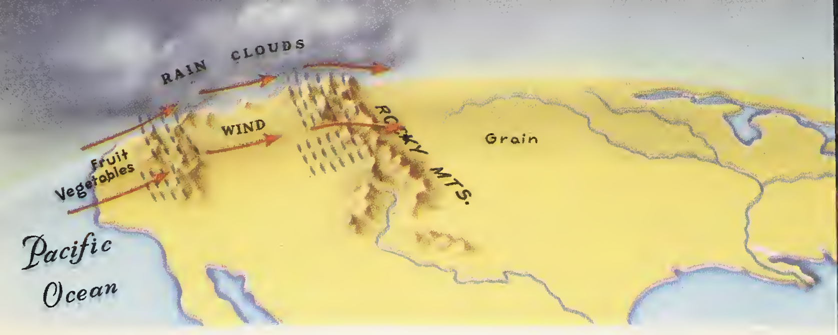
Glasgow and Hebron are about the same distance from the equator. They are both near the Atlantic Ocean. Neither city is built in the mountains. Yet what a difference in their climates! Isn't this a strange thing?

The difference in the climates of Hebron and Glasgow is caused by currents in the Atlantic Ocean. From the Gulf of Mexico, between Florida and Cuba, flows a warm ocean current. It is called the Gulf Stream. It flows northward along the Atlantic coast. Then it swings northeastward toward Great Britain.

The winds blowing toward Great Britain are warmed by this current and make the climate of Glasgow mild.

A cold ocean current flows from the Arctic Ocean into the Atlantic Ocean. This is the Labrador Current. These waters flow from the north-polar region of the earth. This cold current flows along the coast of Labrador. It gives Hebron a very cold climate.

The cold Labrador Current also makes part of the Atlantic coast of North America cold. Could you tell which states are cooled by the cold Labrador Current?



Mountains in the Way

California, Oregon, and Washington have mild climates. These states have enough rain to raise many fruits and vegetables.

Kansas, Nebraska, and the Dakotas have hot, dry summers and cold winters. They are grain-raising states because they do not have a great deal of rain.

Could you tell why these groups of states have different climates? Perhaps the picture above will help you.

The winds blow from west to east across the United States. These winds bring moisture from the Pacific Ocean. But these winds must blow across the Rocky Mountains. When the winds rise to get over the high mountains, they become cooler and cooler. The air finally loses its moisture in the form of rain and snow. The central part of the United States receives little moisture from the Pacific Ocean. The high mountains are in the way.

Now you can probably think of several reasons why a certain place on the earth will have a certain climate. All such things as mountains, nearness to water, and distance from the equator help to give a place the kind of climate which it has.

SOMETHING FOR YOU

1. A great deal of grain is raised on the central plains of Canada. Good grain-raising countries have long, fairly dry, hot summers. Why does the central part of Canada have this kind of climate?

2. Find Chile and Argentina on a map of South America. Southern Chile has a wetter climate than southern Argentina. Why is this?

3. Plan a trip to take in the summer in the tropics. Where could you go and be cool?

4. Locate Italy on a world map. Do you see the great mountain range, the Alps, to the north of Italy? Can you tell why Rome and New York City, which are about the same distance from the equator, have such different climates?

5. Why does the place where you live have the kind of climate it has?

Climates and Living Things

Central American monkey

Prickly-pear cactus

Maple tree

Polar bear

Penguins

Llama

Poinsettia

Where Do They Live?

Should you expect to find these plants and animals living near each other on the earth? Why not?

Polar bears live in a cold climate. Monkeys live in a warm climate.

Each of these plants and animals lives best in a certain kind of climate. Do you know what kind of climate each one lives in?

Warm, Dry Climates

Imagine that we are traveling about the world by airplane. At some time or other we probably pass over land such as you see in the picture below. Of course you immediately say that we are flying over dry land. And so we are — over hot, dry desert land.

As we fly along in our airplane, we notice that the land looks dull. There are no tall, green trees, only dusty green bushes. These bushes are not bright-green. They are gray-green.

There are no cities or villages in this dry region. It is difficult to breathe the hot, dry dusty air. The only movement of the desert seems to be that of the dust which is being blown about by the wind. No large animals move about.

Then in the distance we see a small, black moving object. As we come nearer, we see that it is a moving

automobile. The people in it are crossing this desert as rapidly as they can.

It is not very difficult to cross the Mojave Desert in California. People can drive across it in an automobile. But you may be sure that the traveler has plenty of gasoline, oil, and water before he starts this journey. There are few gasoline stations scattered along the highway.

Now suppose we find ourselves flying above the Sahara Desert in our airplane. This African desert is almost as big as the whole United States.

The journey across the Sahara Desert is difficult. Camels are still used to carry men and goods across the desert, although some people use automobiles. Sometimes it is necessary to stop the journey in the middle of the day because of a great sandstorm.

There is another difficulty which desert travelers must face. There is the great change in the temperature from day to night. During the day it is very, very hot. As soon as the sun disappears, the air becomes cool, and sometimes it becomes cold.

This great change in temperature from day to night takes place because there is so very little water on the desert. As you know, water loses its heat slowly, and land loses its heat quickly.

The sand of the desert has been heated all day by the hot sun, but it does not keep this heat very long. In the evening, after the sun goes down, the sand begins to lose its heat quickly, and the air above the sand soon becomes cold. Little heat comes up from the sand to warm the air which is above it.

If there were large lakes in the Sahara, these lakes would give off their stored-up heat more slowly. They would give off heat all night. Then the air would be warmer.

Suppose we continue our journey across the Sahara Desert. Once in a great while we notice a bright patch of green plants. Here there are trees.

Why do you suppose trees are able to grow here in the desert? Of course there must be water near. Sometimes the water flows across a part of the desert and makes an entire valley fertile. The river Nile does this. It makes the Nile valley fertile.

Most of the time the only water on a desert will be found in a spring or well. This spring or well may give enough water for plant growth.

In the Sahara Desert palm trees may grow near one of these wells or springs. There may be even a few houses in this green spot in the desert. A place of this kind is called an oasis.

Just think how happy desert travelers must be when they come upon an oasis! Here they find water and cool, restful shade.

Places with hot, dry desert climates receive little rain. It is most difficult for people to live in such climates. It is difficult for plants to grow there.

How many deserts do you suppose there are on the earth? Could you locate some of the hot, dry climates of the world? Look for deserts in these places on your world map:

Southwestern United States
Northern Africa
Central Asia
Australia

American Desert Plants

Do you usually think of all deserts as great stretches of sand with no plants? If you have traveled over an American desert, you know that this isn't true.

Cushion cactus

Globular cactus

There are plants on the Mojave Desert, but these plants are not like those we see on farms or in forests or in meadows.

Look at the picture of the Mojave Desert again. Notice the low bushes. Do you see any trees at all? No, the tallest plants on the desert are such plants as cacti, greasewood, and sagebrush.

Just how can these plants grow in a place where there is very, very little rainfall? How can they grow in a place where the thermometer goes up to 134 degrees? You would think that all plants would wilt and die at this temperature.

When you take a closer look at some of these plants, you see that the cacti have only spines for leaves. Sagebrush has very small leaves, too.

Plants lose water through leaves. Plants with such small leaves cannot lose much water, even if it is very dry.

Strawberry cactus

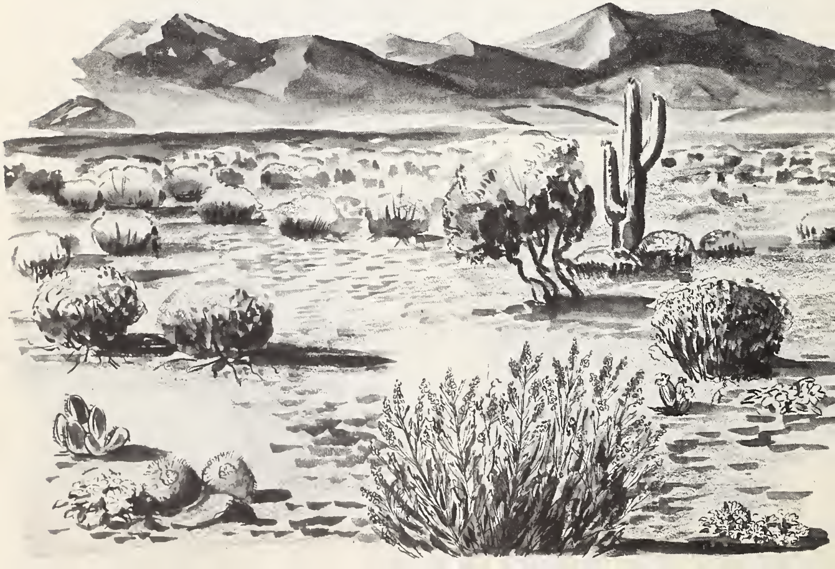
Long mamma cactus

Some types of cactus plants lose so little water that thirsty travelers have found water stored in their stems.

Some desert plants have long, tough roots that grow far down into the soil until they reach water. These plants cannot depend on very much rainfall for their water supply. They must have roots which reach down into the soil and stems which store water.

Most desert plants are grayish-green in color and are covered with dust. The desert almost always has a dull, dry look. However, at times it is very brilliant with color.

One of these times is the time when the cacti and sagebrush are in bloom. The flowers of the gray sagebrush are small and purple. But the flowers of the



cacti are large and bright. They are in many shades of red, yellow, orange, and purple.

The other time that the desert is brilliant with color is just after one of the few rains. Then small plants, such as desert primroses, grow up very rapidly from seeds which have been lying on the soil for a long time.

The picture on the opposite page shows desert primroses and sagebrush in bloom. Desert primroses have very delicate stems and leaves. Their roots do not grow deep into the soil. The roots spread out just under the surface of the soil. In this way they absorb a large amount of surface water.

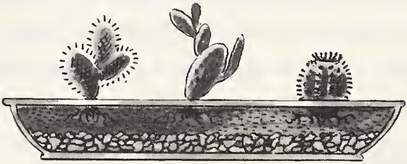
In a few weeks these small plants have beautiful flowers. The plants make seeds, which fall to the ground. These seeds may be blown about until another rain falls. They may be covered with soil. When rain falls, these seeds sprout and grow quickly.

As long as there is enough moisture in the soil, these small, bright plants will bloom. As soon as the moisture has dried out of the topsoil, they die.

Man has caused plants to grow in some desert climates. The Imperial Valley of California would be dry, desert land if it were not for the Colorado River. Man has dug canals from this river into the valley in order to irrigate the land.

The people who live in the Imperial Valley are able to raise many fruits and vegetables. These fruits and vegetables will usually grow only in a climate where there is a good deal of rain. Man is able to grow these fruits and vegetables here because he has dug canals to irrigate the desert.

Perhaps you would like to make a desert garden. Any plants which grow in dry places would be nice for your desert garden. If you would like cactus plants for your garden, you may be able to buy them in a store near your school. Be sure to water your garden once or twice a week.



American Desert Animals

There are many living things other than plants in the desert. The other living things of the desert are animals.

If you traveled over the desert in the daytime, you would see few animals. This is because the animals of the desert stay in the shade and sleep during the hot, daylight hours.

At night the desert animals come out of their hiding places to hunt for food. Many of these animals that sleep during the day and hunt at night are killers. They feed on other animals.

Some of the killers of the desert are snakes and coyotes. Snakes feed on mice, insects, and birds. The snakes rest in a shady place or lie in the sun during the day. At night they hunt for food until the temperature falls too low for them to move about.

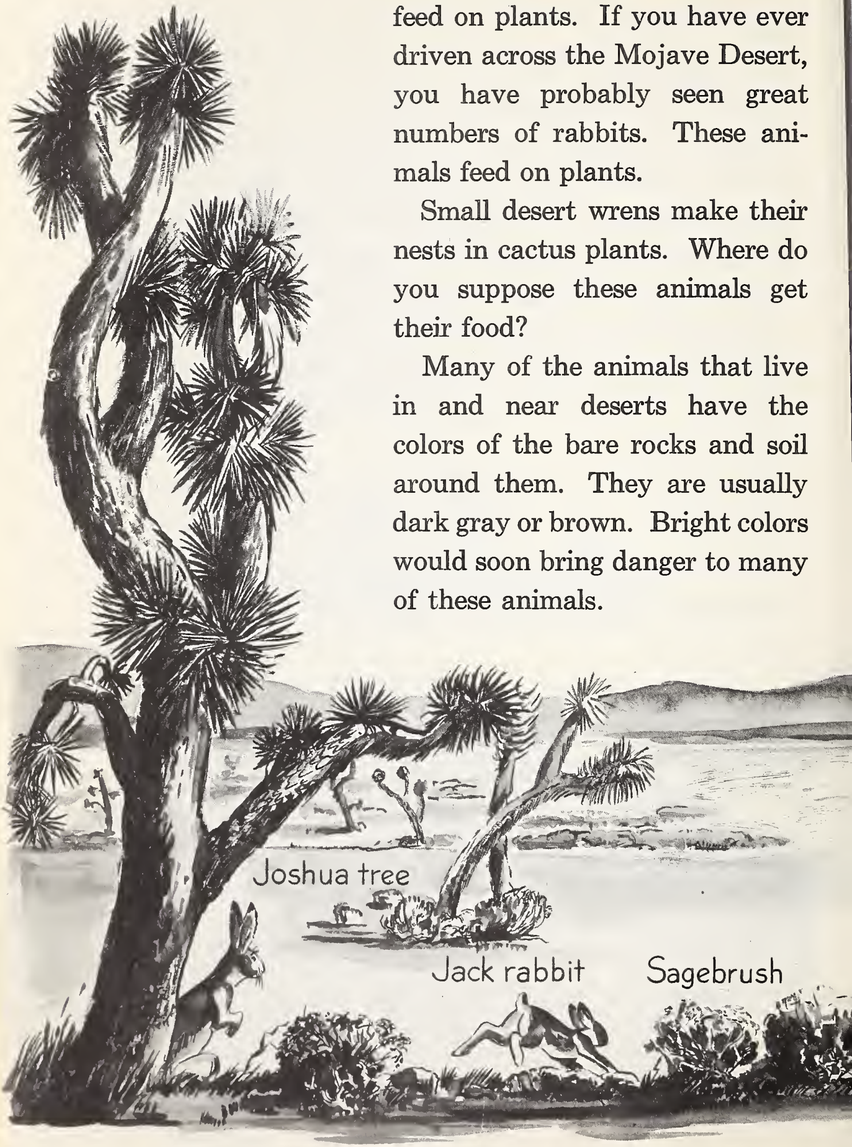
The coyote is an animal which is related to wolves, foxes, and dogs. It feeds on animals which are smaller than it is. The howl of a coyote at night is a very lonely sound.

Some owls and vultures also live in the desert. Owls feed on mice and other small animals. Vultures feed on dead animals. They are useful because they help to keep the desert clean.

Some of the desert animals feed on plants. If you have ever driven across the Mojave Desert, you have probably seen great numbers of rabbits. These animals feed on plants.

Small desert wrens make their nests in cactus plants. Where do you suppose these animals get their food?

Many of the animals that live in and near deserts have the colors of the bare rocks and soil around them. They are usually dark gray or brown. Bright colors would soon bring danger to many of these animals.



There are not a great many different kinds of plants and animals in the desert. The hot, dry climate is not good for most living things.

All desert animals must live near a place where they can get water. Sometimes they depend on small water holes for their supply of water. When these holes dry up, many desert animals die of thirst.

Isn't it a good thing that not more of the climates of our earth are hot desert climates?

Cold Deserts

The warm, dry deserts of Africa, Australia, Asia, and North America are not the only deserts on the earth. There is much desert land in the north-polar and south-polar regions.

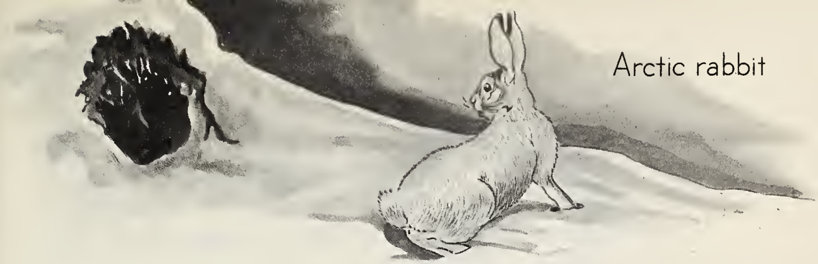
You may say, "How can that be? The polar regions are cold!"

Do you really know what the word *desert* means? A desert is a place where there is little water for plants and animals to use.

Of course there is water in the form of snow and ice in the polar regions. But this water is solid, so that plants and animals cannot use it. There are few living things in the cold deserts of the earth.

Can you think of another reason why so few plants grow in the polar regions? You will probably say another reason is that the cold is great. That is true.

For a month or so, in some parts of the polar regions, the temperature will be above the freezing point of water. But even in the middle of summer a frost may kill some of the plants.

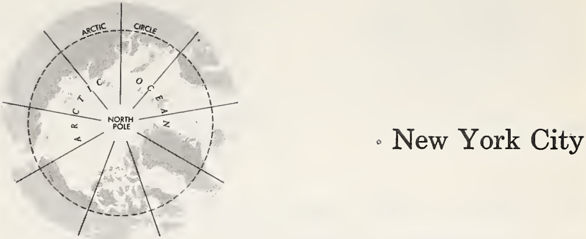


It is true that some animals live in the arctic regions. Reindeer, musk oxen, and rabbits are able to find food even in the winter. They feed on moss and other small plants which are covered with snow. These animals push the snow away and find the plants.

The moss and other plants which reindeer use for food are not dead plants. They are in their winter resting state. In the summer when the snow melts and the sun shines on these plants, they will grow.

Rabbits are able to live through the cold winters, too. These rabbits are not the same kind of rabbits as those which live in the hot deserts. These rabbits spend much of their time in burrows. Sometimes they push back the snow to hunt for food. They eat small twigs and berries too. The color of these rabbits changes as winter comes. Their fur turns white. This is a good thing for the rabbits, since it makes them hard to see.

Other animals such as wolves and foxes live in the cold climates. These animals are meat-eaters. They feed on rabbits and other small animals.



Very few people live in the arctic regions. We are told that not more than 75,000 people live within the Arctic Circle.

The map at the top of the page shows the north-polar region compared with New York City. More than one hundred times as many people live in New York City as live within the Arctic Circle. Why do you suppose this happens?

But what about the south-polar region? So far as we know, not one person lives on the great antarctic continent!

Arctic Winters

Should you like to spend a winter near the north pole? You would certainly live differently from the way you now live.

In all the places within the Arctic Circle which we might visit, one thing would be the same. There would be little or no sunlight during the winter.

During many winter days there would be no sunlight at all. This would not be because of cloudy weather, but because the sun does not shine on the north-polar regions during part of the winter.

Yet the winter darkness is not so black as you might think. Brilliant stars may be seen. Perhaps you say that this is also true in the place where you live; yet the night seems dark to you.

But remember that the arctic regions are white with ice and snow. This white covering of the land and water reflects the light which falls on it. The arctic winter is not one of inky blackness. It is a soft twilight, which is bright enough so that you can see objects about you fairly clearly.

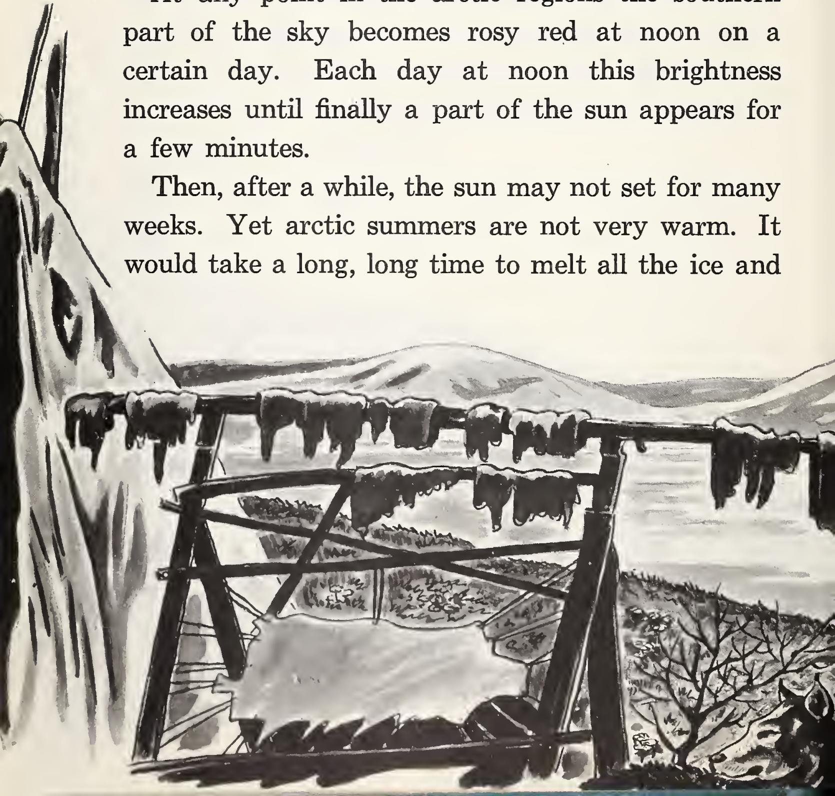
But should you like to live in this twilight for weeks and weeks? The light of the sun would not be the only thing you would miss. You would miss also the heat of the sun.

This part of the earth becomes colder and colder all through the winter. The polar regions are giving off their heat. They are receiving very little heat from the sun.

Arctic Summers

At any point in the arctic regions the southern part of the sky becomes rosy red at noon on a certain day. Each day at noon this brightness increases until finally a part of the sun appears for a few minutes.

Then, after a while, the sun may not set for many weeks. Yet arctic summers are not very warm. It would take a long, long time to melt all the ice and

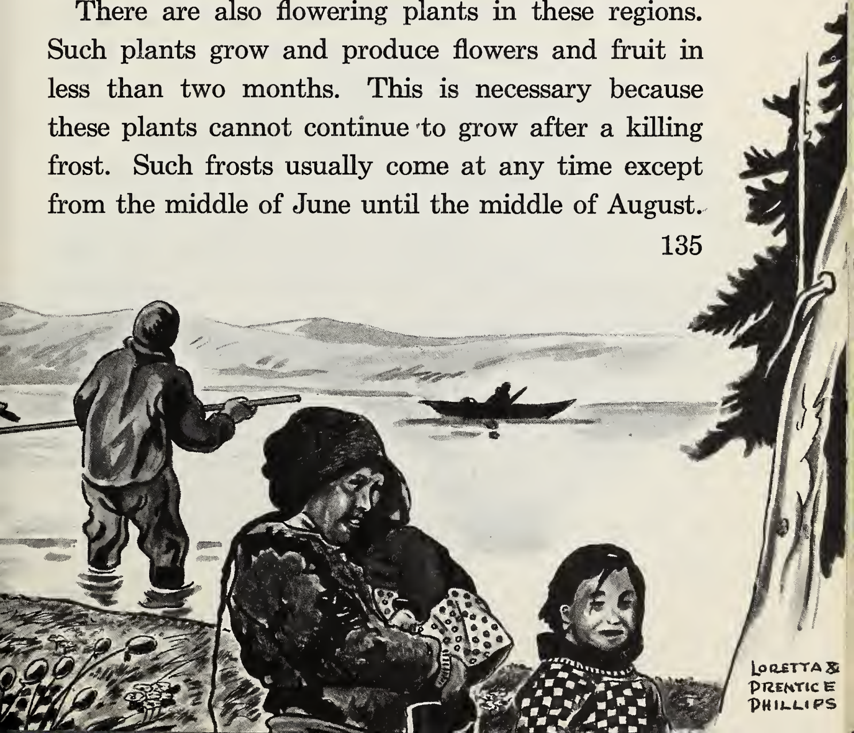


snow. The sun, even during the summer, is always low in the sky. It is never overhead in the arctic regions.

The natives live in tents made of skin during the summer. They move these tents from place to place as they hunt and fish. Since the summer days are cool except at midday, the natives must wear more clothing than we wear in the summer.

Most of the plant life of the cold deserts grows close to the ground. Here there are many small plants, such as moss. These plants live all winter, though they are covered with snow.

There are also flowering plants in these regions. Such plants grow and produce flowers and fruit in less than two months. This is necessary because these plants cannot continue to grow after a killing frost. Such frosts usually come at any time except from the middle of June until the middle of August.



Wouldn't it be strange to live in a place where all the plants grew and blossomed within two months? There would be no large trees, wheat, oats, corn, cotton, or any other plant which must have a longer growing season.

Many of the arctic plants have blossoms of very brilliant colors. The cold deserts are really very beautiful at times.

During the arctic summer many birds appear from the south. Some of these are golden plovers and arctic terns. These birds build their nests and rear their young in these cold regions.

Musk oxen, rabbits, and reindeer find food more easily during the summer. Some of the arctic foxes and rabbits change from white to gray or brown.

In the wetter regions of this cold climate, mosquitoes and biting flies are thick. Man must move to higher and drier ground in the summer.

The arctic summer is short. Ice begins to form on some of the lakes during August. The plants are frozen. Some of them die. Birds have already started on their journeys southward.

During August there are a few minutes each day when the sun is not seen. By the end of September there are twelve hours of darkness and twelve hours of daylight. Soon the sun disappears entirely. It is not seen again until February. The long, cold arctic winter is here.

The South Polar Desert

Perhaps the greatest cold desert in the world is the one surrounding the south pole. The great antarctic continent is covered with a huge sheet of ice and snow. You may never have thought of this as a desert region, but it is. Along the edges of this continent we find some animals, such as penguins.

Arctic fox

But people do not make their homes on this desert continent. You may know that it is only within the last few years that man has explored successfully in this region.

Admiral Richard E. Byrd and his men spent many months in Little America. The picture below shows their main camp. However, even these men could not do much exploring during the long, cold, dark winter.

Most of their explorations were made from December until April, since this is the land of February summers and June winters.

Much of the antarctic continent is yet to be explored. It will be interesting to watch for explorations in both the south-polar and north-polar regions.

Perhaps someday these cold regions of the earth may be of greater use to us. But at the present time such very cold climates, with little plant or animal life, are of little use to us.

Warm, Moist Climates

Should you like to live in a place where there is never any cold weather? Where would you go if you wished to live in such a climate?

Some places on the earth have warm winters and warmer summers. They are located in or near the tropical regions of the earth.

Here is a short list of some of the cities in such regions. Can you make a longer list of it?

Havana, Cuba
Belém, Brazil
Miami, Florida
Monrovia, Liberia, Africa
Singapore, British Malaya
Manila, Philippine Islands

Of course some of these places are colder than others during the winter months. Havana has a slightly cooler winter than Singapore. Can you tell why? None of these places, however, has a very cold season and a very hot season. The temperature stays about the same all year long.

Let's think for a moment just what it would be like to live in a city which has a warm climate all the year round.

First of all, we should not have to worry about different clothing for summer, fall, winter, and spring. We should wear the same kind of clothing all year. A very light coat would be of use at times. But a raincoat would be much more useful than a heavy woolen coat.

Our houses would need no large fireplaces or furnaces for heating. As for food, we should have fresh fruits and vegetables every month in the year. There would be no very cold weather to keep us from having a garden.

There would always be flowering plants. It would be necessary to see that the plants had plenty of water, for the hot sun would cause water to evaporate very quickly.

What fun you would have playing games! It would never be too cold to go swimming. Tennis and baseball would always be in season. However, it would be best to play such games in the morning or late afternoon. Early afternoon is usually very warm in such regions. People like to take a rest until four or

five o'clock. They usually rest during the hottest part of the day.

The tropical regions of the earth have a warm climate. These regions always receive a great deal of heat and light from the sun; so it is warm all year long.

Rain Forests

The people in the tropics do not always use the names *summer* and *winter*. They call their seasons the rainy season and the dry season. In some of the tropical regions the two seasons might be called the rainy season and the less rainy season. The Amazon River region of South America has just such a climate.

All along the Amazon we find the tropical rain forests. Suppose we could explore the Amazon and some of the streams which flow into it. This great river is so deep that ocean vessels can travel over two thousand miles upstream.

Suppose we travel up one of the many streams which flow into this great river. No matter what time of the year it is, the plants along the banks are always green. Could you tell why this is true?

Then suppose we leave the river and travel into the jungle. Vines form a curtain from the treetops to the water's edge. We wonder if we shall ever be able to find our way through the jungle.

As we travel away from the river into the dense forest, we find few small bushes or trees. The trees are tall and straight. There are few branches near the ground, but many near the tops of the trees. Sunlight does not often reach the forest floor. It is always warm and damp there. Blooming vines grow to the tops of the trees. In this way they receive as much sunlight as possible.

South American bird

South American butterfly

The sky will probably be clear when we start our trip in the early morning. About noon we have to seek shelter. Dark rain clouds are beginning to gather.

In the early afternoon the storm begins. All at once the rain seems to crash down on us. Trees and vines bend this way and that. There is lightning and thunder. Then, as suddenly as it came, the storm is over. The sun is bright again.

A sudden storm of this type is common in the tropics. During many weeks of the year there is one about the same time every day. A slow rain which lasts for several days is rare in this region.

As you might expect, there is much animal life in the tropical rain forests. There are not many large animals roaming the floor of the forest, because it is difficult for them to find food there. The greatest amount of food is in the treetops, where the fruits of the trees and vines are growing. Here we find many different kinds of beautifully colored birds. Many climbing animals, such as monkeys, live in the trees.

Central American beetle

South American snake

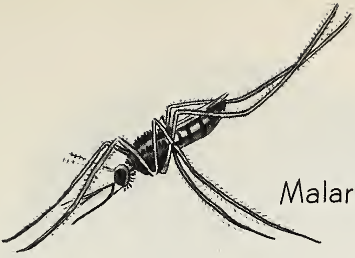
There are also snakes in the trees and snakes, alligators, and toads near the streams. But we find more insects than any other kind of animal. There is always a hum of insects in the tropical rain forest.

There is always a great deal of plant and animal life in these regions. This is one region on the earth where there is enough rainfall and heat for all plants to grow all year. Because of this there is always food for animal life.

Man, however, finds it difficult to live in this land of summer. It is easy for him to find food. In fact, someone has said that here man is only a food-gatherer, not a food-grower.

Why, then, is it so hard for man to live in the rain forests? First of all, it is not easy to cut through the forests; so the villages of this region are usually found along streams. It is possible to travel by boat from one village to another. However, it is very difficult to travel through the forests.

The houses in the villages are built on stilts because the ground is always moist. It is even flooded



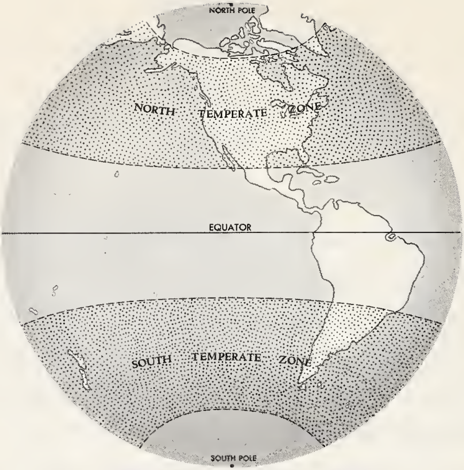
Malaria mosquito

during the rainy season. The moist, hot air of the forests is very uncomfortable.

Perhaps the chief reason why many people do not live here is the presence of so much disease. Some of the insects of the rain forests carry such diseases as malaria and sleeping sickness.

At the top of this page is a picture of a mosquito which carries malaria germs. You would have to guard yourself against the bite of this mosquito. At the top of the opposite page is the tsetse fly, which carries sleeping-sickness germs. People protect themselves from these animals at night by sleeping under mosquito netting.

We now have certain medicines which help to cure malaria and sleeping sickness. We hope that someday men will really be able to conquer all tropical diseases. Then they may be able to live in the tropics more comfortably and more safely. They may be able to make better use of these warm, moist climates. Today you and I would find it hard to explore the rain forests and almost impossible to live there.

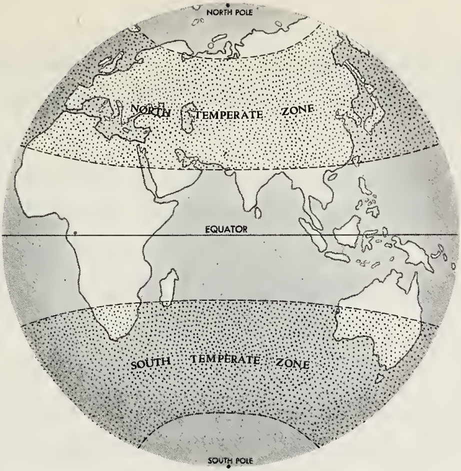


Temperate Climates

Do you live in a climate which has warm summers and cold winters? Do you have rainy seasons and less rainy seasons? Do you have four different seasons? If you have this kind of climate, you probably live in a temperate climate.

The pictures on these two pages show you where the temperate climates of the earth are located. Can you find where you live?

In the north temperate zone, which is north of the equator, you will find the United States and parts of Canada, Europe, Asia, and Africa. In the



south temperate zone, which is south of the equator, you will find parts of South America, Africa, and Australia.

Though all these places are in the temperate zones, they do not have exactly the same kind of climate. But all these places do have "in-between" climates.

We say that the United States is in the temperate zone, but not all places in the United States have exactly the same kind of climate.

Summers in Oregon are different from summers in Georgia. Winters in Texas are different from winters in Michigan. The rainy season is of different length in each of these places. Then, too, the amount of rain and snow that falls is different in each of these places.

It would be most difficult to describe all the many plants and animals of these temperate regions. We know that there are forests, great grassy plains, gardens, orchards, deserts, and fields of cotton, corn, and wheat in these zones.

In fact, much of the food of the world is grown in these regions on farms such as the one shown below. Food crops grow well here because there is a long, moist, warm growing season and a long, fairly dry harvest season.

The reason for these temperate climates is that these parts of the earth never receive the direct rays of the sun. During one season, however, the

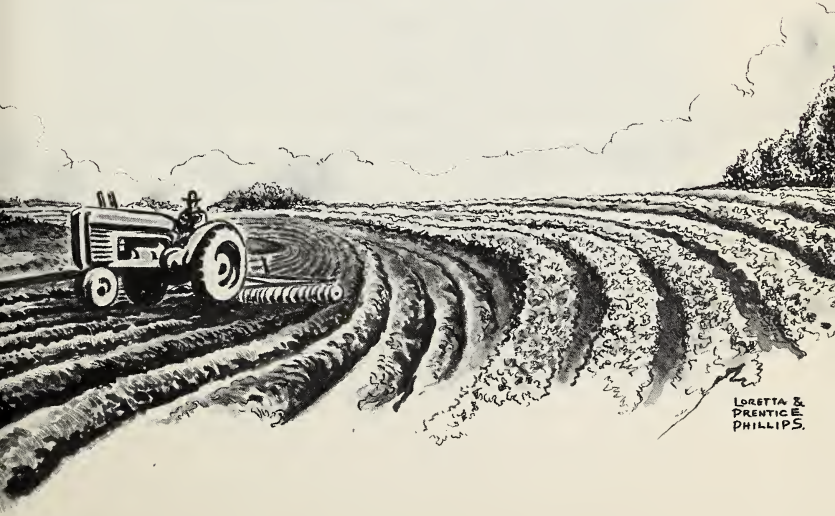
sun's rays are more nearly direct than at any other time. So this is summer, the warmest season.

During the winter the sun's rays are less direct than at any other time. So this is the cold season. Yet the winters in this part of the earth are usually not so cold that people suffer.

There are many different animals in the temperate climates. Some of them live in very wet places; some live in forests; some live in meadows.

Look about your home and school and see how many different plants and animals you can think of which live in your temperate climate.

Man has found the temperate climates to be very good places for living. He has been able to explore them without too much difficulty. Heat and cold have not held him back.



People live in many different ways within the temperate regions. In some places only a few people live on great ranches, with hundreds of acres of land about them. Many people live on small vegetable farms. Thousands live in villages, towns, and cities.

When we think a moment, it is not surprising to find these differences in the ways people live in the temperate climates.

Vegetables will grow on few of the great ranches because there is not enough rainfall. There may be small gardens on these ranches, but the people who live here make it their main business to raise cattle to ship to other parts of the country.

The cattle will be used for food and to make clothing. Ranch land is good for growing grasses on which cattle feed.

Some parts of the temperate regions are suitable for truck gardening. Such places have rich land and plenty of rain. Some places are suitable for dairying. Thick grass grows there all summer. Other places are suitable for the growth of trees or for raising wheat.

So we see that rain and sunshine — the things that help to make a climate — have much to do with the way that people live in the temperate regions of the earth.

SOMETHING FOR YOU

1. Do you like exciting stories? Read about the exploration of Antarctica by Admiral Byrd. Read about the conquering of yellow fever in the tropics by Dr. Reed, Dr. Lazear, and Dr. Agramonte.

2. Here is an experiment that may help to show you how plant life holds moisture in the soil and keeps it from becoming very hot.

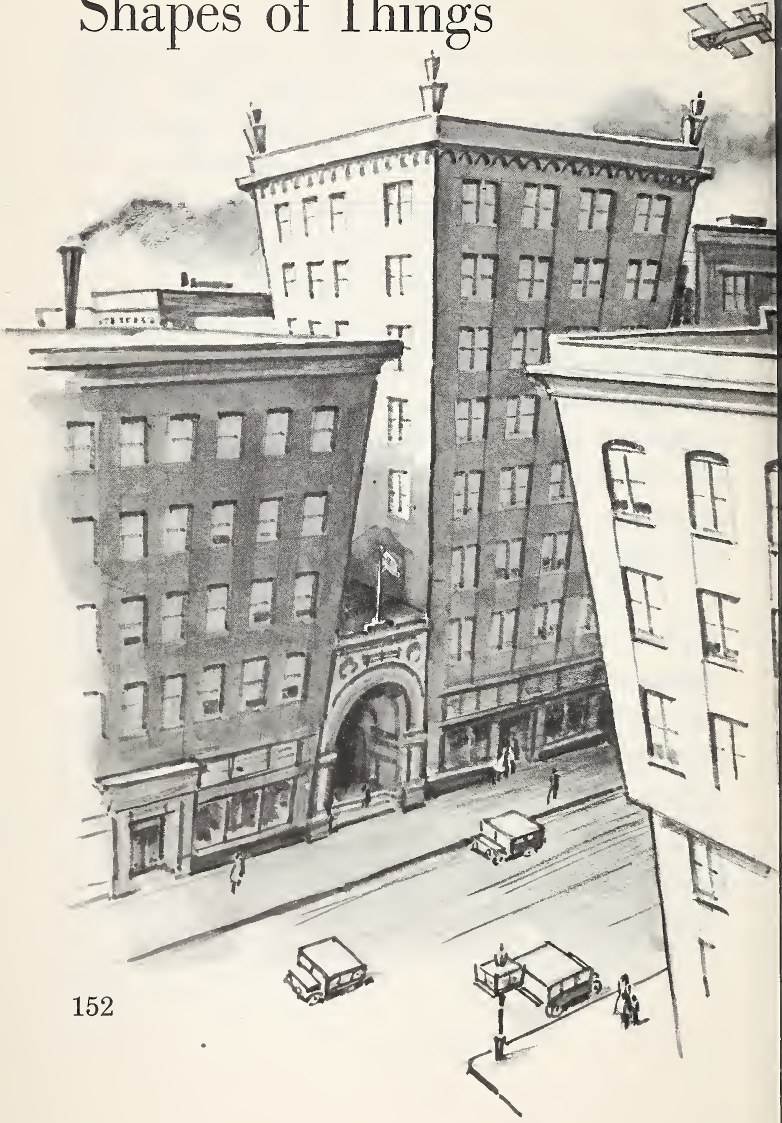
You will need two small, flat pans. Fill one pan with dry sand. Into the other put soil on which moss and other small plants are growing.

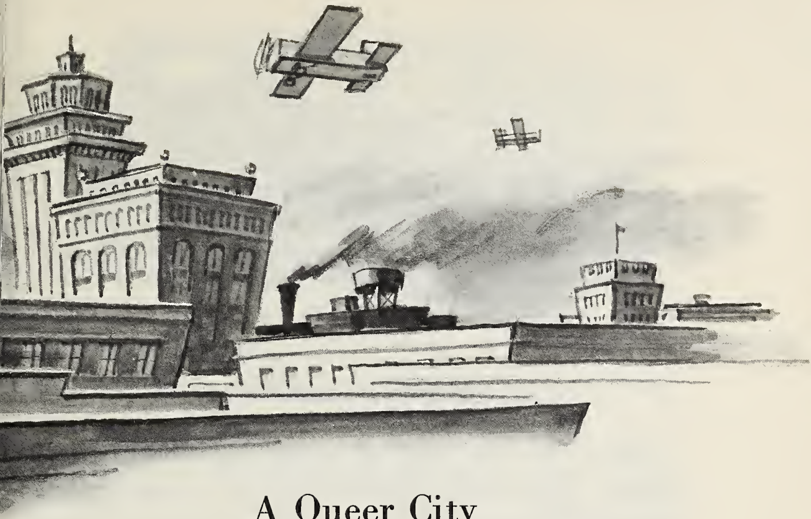
Put the pans outdoors in the sunshine. Every hour use a thermometer to find the temperature of the soil in each pan. Keep a record all through the day. Do you see why desert soil gets so hot?

3. Where should you expect to find the greatest numbers of people living on the earth? Ask your teacher to help you find information about this.

4. Climates change, but it takes hundreds and hundreds of years for the climate of any one place on the earth to change. We can be sure that the climate of any part of the earth will be much the same as it is now all our lives. Why is it a good thing that climates change very, very slowly?

Shapes of Things

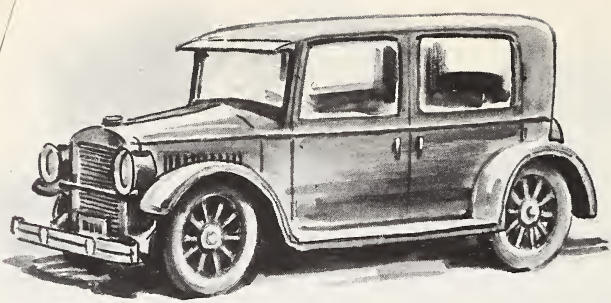




A Queer City

What strange buildings there are in this queer city! They are narrow at the bottom and wide at the top. Automobiles which are wider than they are long move along the roads. Square airplanes fly through the air.

Where do you suppose this queer city is located? You have never seen a city like it; neither has anyone else. This is just an imaginary city. It is a city where the buildings, automobiles, trains, and airplanes have just the opposite shapes from the shapes we know. Do you know why our airplanes are not square and why our buildings are not narrow at the bottom?



Automobiles and Trains

Have you ever seen an automobile like the one above? You may have seen one in a museum, or perhaps someone you know still owns one of these automobiles. It certainly does look different from the automobiles of today.

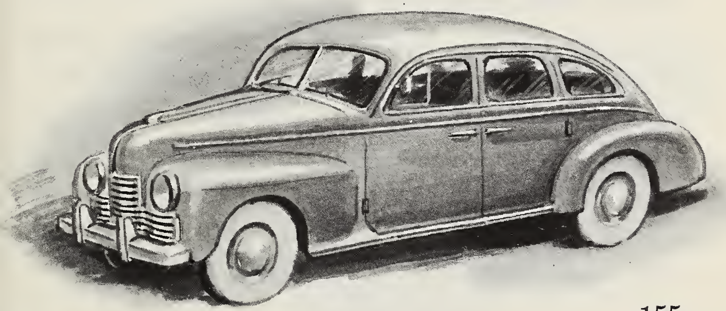
This automobile is not a very old one, though it does look very different. This is the kind of automobile your father and mother may have taken rides in when they were just your age. Ask them to tell you about the first automobile they can remember.

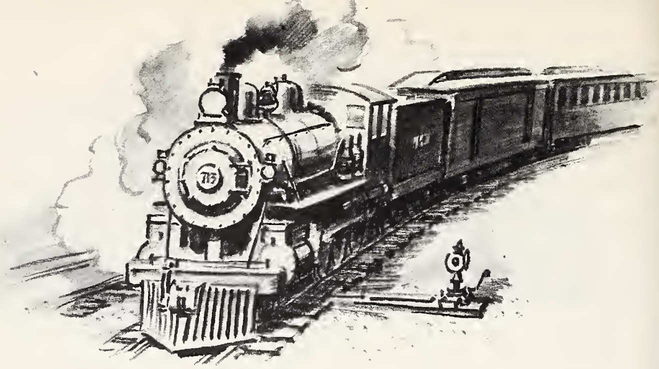
Compare this automobile with the one on the opposite page. What are some of the differences? The engine cover, or hood, on the older automobile is more nearly square. The front of the radiator is not very pointed. Look at the top of the automobile above. Notice how flat it is.

The more modern automobile has a hood and radiator that seem to fit right into the rest of the body. You can see that the top of the automobile is really a part of the body, too. It does not look as if it were put on after the main part of the car was finished.

Notice that the automobile of today looks smoother. It seems to be all one piece. There are very few things which go out beyond the main body of this automobile.

Headlights are placed in the main body. They are not on the outside of the body. There are no running boards. You can step right into the car from the ground. Fenders seem to be more a part of the automobile, too. You do not notice them as much as you do in the older type of car. There have been many changes in automobiles in the last few years.





Suppose you could suddenly go back and visit your mother when she was a little girl. It is summer, and you are going on a vacation. You will not drive. This is to be a train trip.

This trip will be a very exciting one. You will ride on one of the fastest trains in the country. You will sometimes travel as fast as 50 miles an hour.

Now look at one of the fastest trains of today, which is shown on the opposite page. How should you like to take a trip on this train? Sometimes it travels as fast as 80 miles an hour!

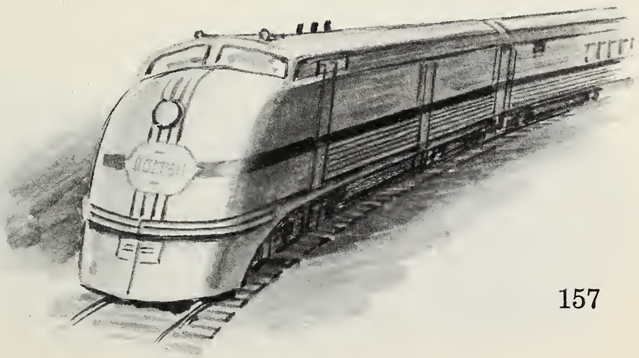
Do you see any differences in the shapes of the two trains? Notice the two locomotives. They look quite different. The older locomotive has lights, wheels, and other things sticking out from its main body. You have the feeling that these things are not really a part of the main body of the locomotive. They look stuck on.

You do not have this same feeling when you look at the locomotive below. The lights and wheels all seem to be a part of the locomotive. The whole locomotive looks smooth and sleek.

The same thing is true of changes in trains as is true of changes in automobiles. Locomotives and automobiles look almost as if they were made in one piece.

Why do you suppose the engineers who designed newer trains and automobiles made these changes? You may say that the newer automobiles and trains are now more beautiful. Yes, they are. Their shapes are more pleasing to us.

There is a more important reason for these changing shapes. Modern automobiles and trains travel faster. One reason is that they have better engines. They also have better fuel. Another reason is that they have smoother shapes.



Through Air and Water

Automobiles and trains of today are built so that they can move faster. They are built to move faster through the air. Very little of an automobile or train touches the ground. Most of it really does move through the air.

You know that air is a real thing. It presses on us. As we walk, we push through the air. Whenever anything moves through the air, it is held back. Air is strong enough to hold things back. Automobiles and trains must move through the air. They push the air aside as they move along.

This experiment may help you to see how air can hold things back as they move through it. Hold a piece of paper flat against your hand. Now throw it across the room with as much force as you can. Did it go very far? Make a light chalk mark on the floor where the paper fell.

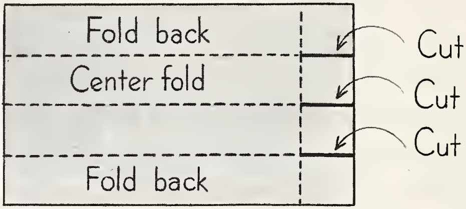
Take the same piece of paper. Crumple it into a tight ball. Stand in the same place that you were standing in before. Now throw the paper as hard as you can. Did the paper go farther this time?

Perhaps you can explain why you could throw the crumpled paper a greater distance than the flat paper. Certainly the crumpled paper was not lighter. You used the same piece of paper each time; so the weight was the same. You may not have used exactly the same amount of force each time. However, each time you threw as hard as you could; so the amount of force was about the same.

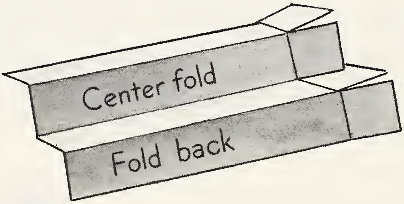
But you did do something to the paper. You changed its shape. The flat piece of paper had to push against more air as it traveled through the air. When the paper was crumpled, it did not have to push against as much air. It could travel faster, though you used about the same amount of force each time you threw it.

You have probably made paper gliders. Here are directions for making gliders in two different ways.

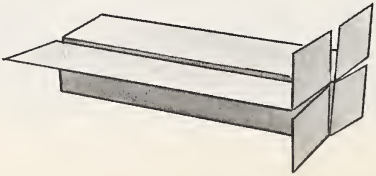
You will need two pieces of paper, each about 8 inches wide by 12 inches long. Draw on one paper the lines you see in this picture. Cut along the heavy lines.



Now fold the paper along the center fold, and then fold back the two outside edges, like this:

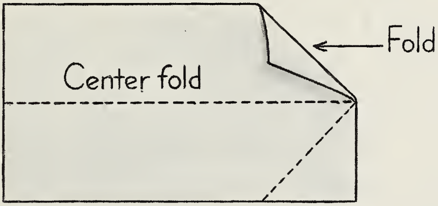


Fold the cut ends so that they make a flat nose for the glider. Here is the finished glider. Doesn't it look queer? Throw it as hard as you can through the air. Does it go very far?

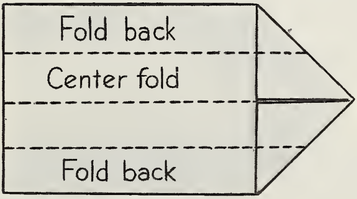

Finished glider

Now you are ready to make the other glider. You have probably often made gliders like this one. Keep the first glider to compare with this one.

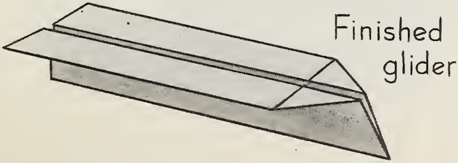
Draw these lines on your second piece of paper, and fold the corners back as shown in the picture.



Now draw these lines, and fold the paper along the center and back at the edges.



Does your second glider look like this one? Compare this glider with the one on the opposite page. Is it heavier than the other? No, the gliders were made of paper which was about the same size.



Throw this glider across the room as hard as you can. This one travels much farther with about the same amount of force, doesn't it? Can you explain why this happens? Remember that both gliders weigh about the same and were thrown with about the same amount of force.

The secret of the longer flight of the second glider is in its shape. Its nose is pointed. The nose of the first glider was flat and square. The pointed-glider nose did not have to press against as much air as it cut through the air.

Do the two experiments which you have done help you to understand why changes have been made in the shapes of automobiles and trains? The smoother and less flat the shape, the faster the automobile or train can travel through the air. This smoothing of shape is called streamlining.

We streamline our automobiles and trains because they must go through air. They can go through air more easily if they do not have flat noses.

Water is strong, too. It takes force to go through water. You make your body as smooth and straight as you possibly can when you are trying to swim fast. You can go faster if you put your head down in the water so that it will make a smooth line with your body. If your head sticks up from your body, you cannot swim as fast.

Wouldn't it seem silly to try to swim in the position of the boy on the opposite page? Most of his body is pushing flat against the water as he is moving through it. The boy who is shown below can swim faster. His body can cut through the water more easily. His body is more streamlined as he swims along.

Airplanes and Boats

One of the nicest things to do after you have had a picnic on a warm summer day is to lie on the grass and watch the sky. There are sometimes puffy white clouds floating overhead. You can imagine that they are great castles or even cities. Sometimes the clouds remind you of animals or people.

As you watch the clouds, you may see birds soaring in the sky. Have you ever seen hawks like the ones above? If you were on a beach picnic, you might have watched gulls soaring overhead. Once in a while their wings moved; then they seemed to float through the air, without any movement of their wings.

These birds are very beautiful. Their feathers are smooth and sleek. Their bodies are streamlined. When they fly, these birds pull their feet up close to their bodies. Their heads are in a straight line with the rest of the body.

In other words, the body of the bird is smooth and straight from the tip of its beak to the end of its tail feathers. This helps the bird to cut through the air easily. Wouldn't it seem queer to see a bird flying along with its head sticking up and its feet hanging down?

Look at the passenger plane below. Does its shape remind you of the shape of a soaring bird? We have shaped our airplanes in much the same way as a bird's body is shaped. Do you see the smooth, sleek body of the plane?

Several years ago the landing wheels of an airplane did not fold up into the body. They hung down as it flew along. The cover of the cockpit was raised above the rest of the plane. Now the wheels fold up. Very little, if any, of the cockpit rises above the rest of the plane.

These things help the plane to go through the air more easily. An airplane is streamlined

Watching fish is fun. They dart through the water without moving their bodies very much. Fish are able to swim by moving their whole body very quickly and by using their fins.

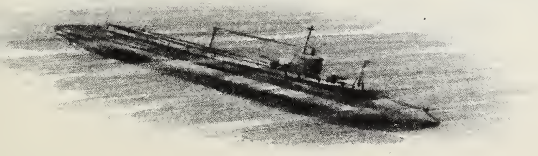
You remember that water is strong. A fish has to use force to push its way through the water. Its body is smooth and sleek. This makes it easier for the fish to move along. A fish's body is shaped so that only a little force is used as it swims.

Almost all the different kinds of fish have scales. Water does not stick to these scales. They do not soak up water and make the fish's body heavier. It would be much harder for a fish to swim if its body were covered with fur. Water would stick to the hairs and make the fish heavier. A fish would then have to use more force to swim.

Fish have no arms or legs. Because of this, their bodies are more streamlined. They can move along more easily. A fish's body is very smooth. It does not even have ears which stand out from its head.

Look at the boats below. The shape of a submarine is very much like the shape of a fish. Submarines are as smooth and straight as they can possibly be. The only raised part of the submarine is the tower. A submarine must be built so that the whole boat can move through the ocean easily and quickly.

The top of an ocean liner is not as smooth as the bottom. The part of the liner which is under the water must be smooth so that it can cut through the water easily. The tops of ocean liners go through the air. The tops of these boats are smoother than they once were. The whole boat is as streamlined as possible so that it can move through water and air.

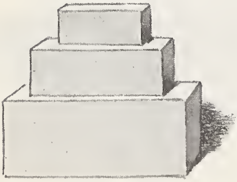


About Balance

Have you ever watched a little boy or girl playing with blocks? You probably played with blocks once, but you may have forgotten about it. If you can borrow some blocks, you may discover some interesting things about the way we build.

If you do have some blocks or pieces of wood, try to build them in the way shown in this picture. Do you think all the blocks will stand up? Why not? Which ones do you think will fall over? Why?

Did you say that number 2 and number 6 would fall over? You are right. Unless you build numbers 3, 4, and 5 very carefully, they will fall over, too. Number 1 is very steady. It is easy to build. It will not fall over easily. The first block towers that little children build often look like number 1.



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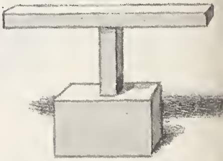

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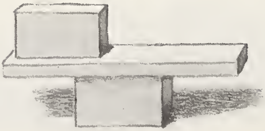
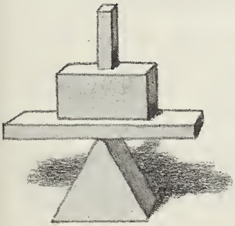


2

Number 2 will fall over easily. It is not well balanced. There is too much weight on one side. Number 3 can be so well balanced that it will not fall over. To do this, the exact center of the top board must be placed on the middle block. This makes the weight of the top board equal on each side.

Number 4 is hard to build, too. Unless each of the blocks is placed exactly in the center, the three top blocks will fall over. This is also true of the towers on number 5.

If you build very, very carefully, you may be able to build part of number 6. The first block will stand up. You may be able to put the second block in its place. Do you think you could ever put the two top blocks in place? No, they would fall over right away. They are not balanced. The blocks in number 2 and number 6 are out of balance.



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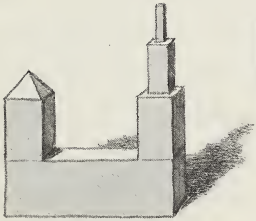

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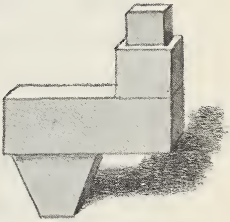

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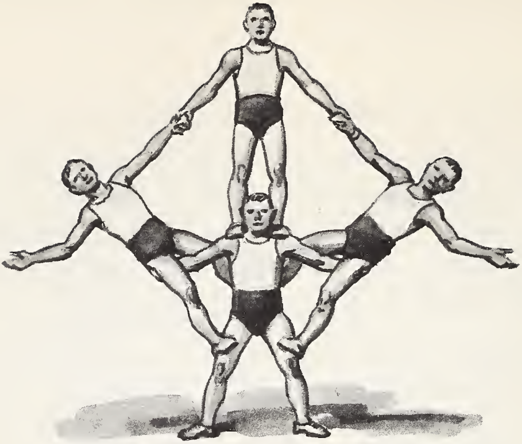


Acrobats must learn the secret of balance, too. The men shown above are equally balanced. The top man places his feet on the shoulders of the bottom man so that his weight is equally balanced. The two men on each side weigh about the same. They pull with an equal amount of force in opposite directions.

The two acrobats on either side must be very careful to take their positions at the same time. They must pull in each direction at the same time. If one tries to take his position before the other does, the center man is pulled off balance.

Notice that the feet of the center man are wide apart. He would have a very hard time balancing the other men if his feet were close together. His feet make a wide base for easier balancing.

If the center man's feet were close together, he would find it very hard to balance the other three men. It is difficult to balance a wide thing on a small base. The center man holds his feet wide apart. The "tower" he helps to make looks more like the tower of number 4, on page 169. It is easier to balance a wide thing on a large base.

Have you ever seen a dog or some other animal which was trained to walk or stand on a large ball? This is a very hard thing to do. The dog must keep his body perfectly balanced.

What do you suppose would happen if the dog leaned too far forward? What would happen if he leaned too far backward?

Trained dogs can roll the ball along the floor, but they must move their feet very quickly. They must also hold their feet close together. The most important thing that they must do is to keep as much weight on one side as the other. They must balance.

The men who plan buildings think about balance, too. The shape of a building must be such that there is not too much weight on one side. A building must be balanced if it is not to fall over.

The shape of a building tells you something about the way a building is balanced. If any part of a building is narrow, the narrow part is almost always at the top. This is true of many skyscrapers. Such tall buildings are often very narrow at the top, compared with what they are at the bottom.

Look at the city below and then turn back to the picture at the beginning of this chapter. In the picture of the "queer city" the buildings are broad at the top and narrow at the bottom. If these build-

ings were very carefully built, they would not fall over, but it would be harder to build the "queer city" than it would be to build the city below.

Many of the large apartment houses in this city look almost square. Their walls go straight up. There are no narrow towers on the tops of these buildings. They are very sturdy.

Even the tall chimney is built so that it is well balanced. It is broader at the base than it is at the top. If you look at a chimney from a distance, it may look as if its sides went straight up from the base. If you look closely, you will see that it becomes more narrow near the top.

Do you see that people really balance buildings in much the same way as children balance blocks?

Bridges too are built so that they are balanced. Many of our bridges, like the one above, are arched. Have you ever noticed one of these arched bridges? There is probably one near your house. They are fairly common.

Engineers who build bridges must work out very carefully the design of a bridge. They must know the weight of the bridge and the load it will carry. They must also know how long the bridge must be. After they have all these facts, they are ready to design the bridge.

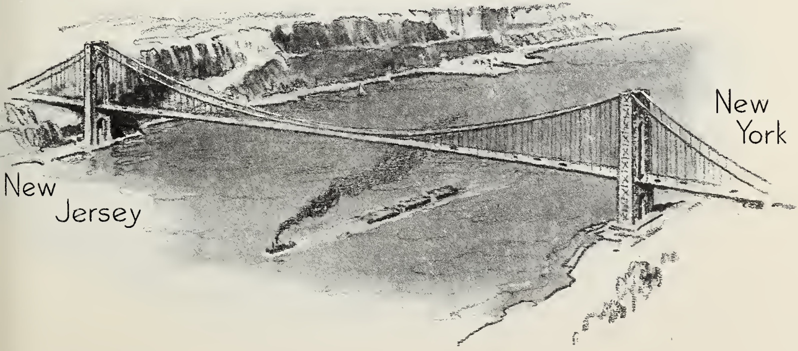
One of the most important things to do in building a bridge with arches is to make the arches just broad enough. If the arches are too broad, the bridge may break with a heavy load.

Each of the pillars of the arch must be wide and strong. These pillars support a great deal of weight. They support the roadbed of the bridge and the trains or automobiles which use the bridge.

We also build bridges that have other shapes. In some places it is not wise to build an arched bridge over a river. The river may be so deep that it is hard to build the arches properly. Sometimes large boats go up the river. The boats may be too large to go through the arches.

In such places we may build suspension bridges. These bridges are often made almost entirely of steel. The picture below shows a famous suspension bridge. The whole bridge is more than a mile long. This bridge crosses the Hudson River. It takes automobiles, trucks, and busses from New York City to New Jersey. This bridge has a name. It is the George Washington Bridge.

This bridge is very well balanced. The roadbed between the two tall steel towers is held up by very strong steel cables. The bridge was carefully designed so that the roadbed and its load of automobiles and busses would not be too heavy for the cables. This is a beautiful bridge. It is well built.

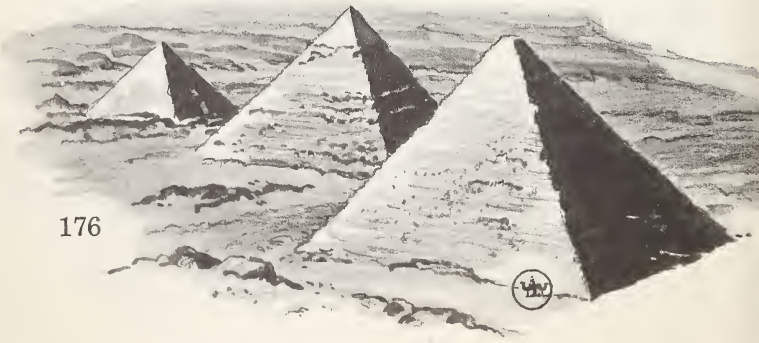


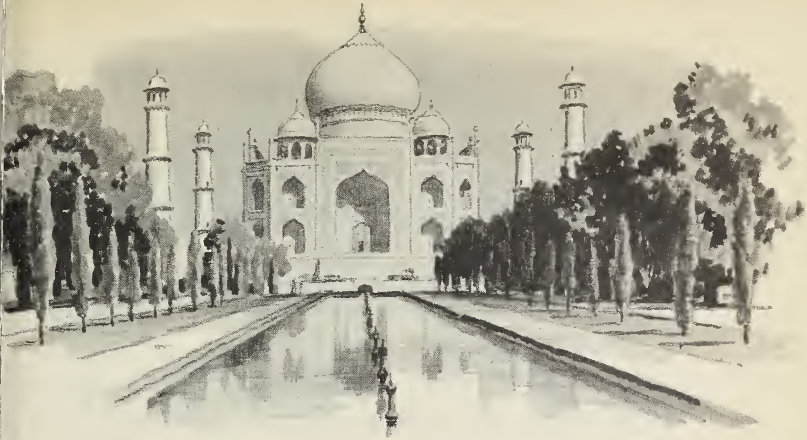
Buildings of the World

People all over the world have been building houses, temples, and other kinds of shelters for a great many years. Many of the ancient buildings are so well built that they are still standing today.

Below is a picture of three very famous old buildings. They are about five thousand years old. We call them the Pyramids. These three pyramids are near the mouth of the Nile in Egypt. They were built by some of the kings of Egypt. The Pyramids are the tombs of these kings.

Notice how well balanced these buildings are. They are broad at the base. Then they become more and more narrow toward the top. They end in a point. These are sturdy buildings. The Pyramids are built of very large pieces of stone. These stones were cut and shaped by hand. Then they were put into place. Do the camels at the base of one of the Pyramids give you some idea of their size?

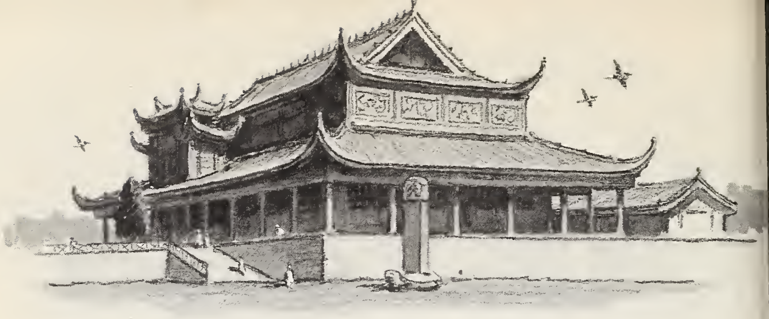




This is another very old building. It was built about three hundred years ago. A ruler of India built it to honor his queen. It is not a very tall building, as you can see if you compare its height with the height of the trees.

The building has a name. It is the Taj Mahal. The people who put up this lovely building so long ago knew how to build well. They used strong stone which would not be worn away easily by rain or dust storms. Have you ever seen marble? The Taj Mahal is built of white marble which was polished by hand.

Look at the building carefully. Do you think it is well balanced? Does it have a wide, strong base? The graceful towers are well built, too. They are wider at the base than they are at the top. How well these people built so many years ago!



Here is another very old building. Did you guess that it was Chinese? This Chinese temple was built hundreds of years ago. You have probably never seen a Chinese temple or the Pyramids or the Taj Mahal. However, you may do so someday. We shall be able to travel to China or Egypt or India in a few days if we go by airplane.

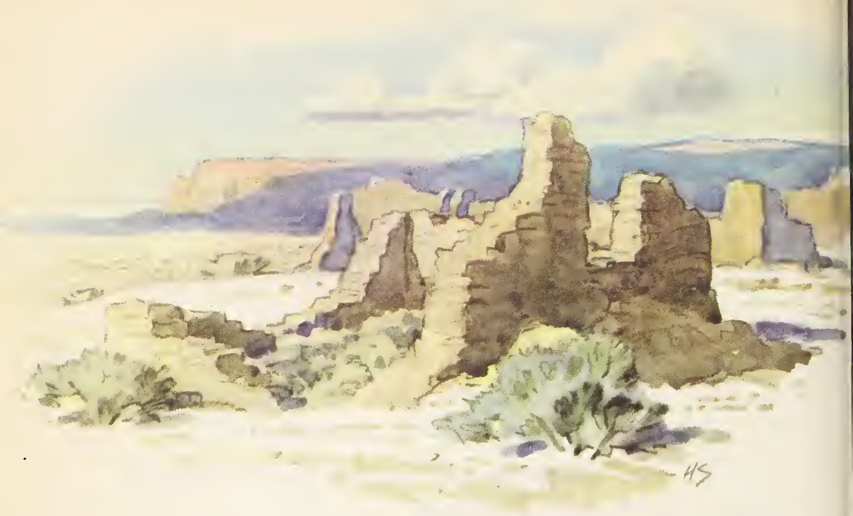
This Chinese temple is not a very large building. Compare it with the people who are near it. If you just glance at the temple, you may say that it was built very differently from the Taj Mahal or from some building which you know. To be sure, it does look different. Is there a building near where you live which has its roof turned up at the corners?

Yes, this Chinese temple may look queer to you, but notice the design of the building. It has the same general design as buildings you know very well. There is a wide strong base. The decorations are well balanced on this base.

Below is a picture of another church. It is almost half way around the earth from the Chinese temple. This is the great cathedral at Reims in France. It took many, many years to build this church. It was finished about six hundred years ago.

This is a tall building, although it is not so tall as some of our modern skyscrapers. The people going into the cathedral may give you some idea of its height. There are lovely towers on this church. There are also many small spires and other decorations. All these towers and spires are very carefully balanced on a large, strong base.

The stones of which Reims Cathedral is built are large. They are very thick. Though these stones have been washed by rain for a long time, they are still strong. This cathedral should stand for hundreds of years more.



These are some interesting old houses. Indians who lived in the part of North America which is now the southwestern United States built houses like these before the white man came to this country.

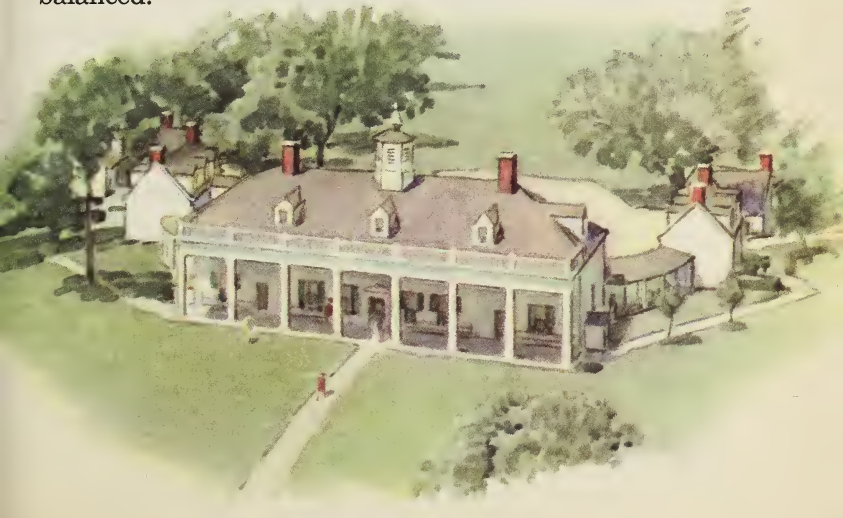
The houses in the picture are no longer used. The materials of which they were built were not as strong as the building stones of the Pyramids or the Taj Mahal. The houses of these Indian villages were built of sunbaked earth.

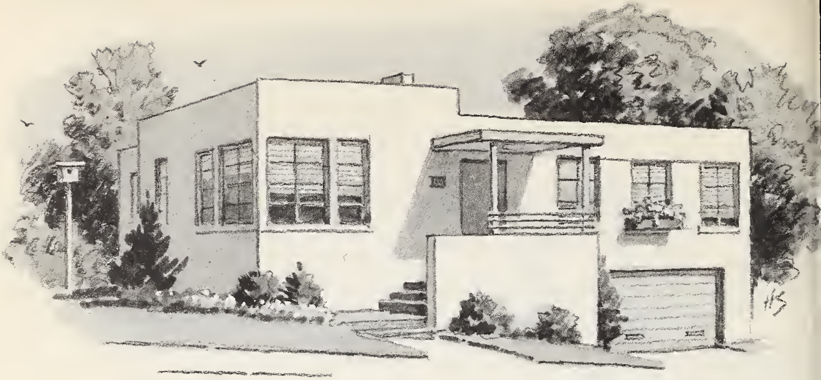
Rain has washed some of the earth away. The walls have become weak, and they have fallen. If you look carefully, however, you will see the same square, well-balanced bases that you have seen in other houses.

Below is another North American house. It is the most modern of the buildings about which you have been reading. This is not a new house. It is over two hundred years old. Have you ever seen pictures of this famous home? Perhaps you have visited it.

This is Mount Vernon. It was the home of George and Martha Washington. This lovely old house is on the Potomac River not far from the city of Washington. Beautiful green lawns and several smaller buildings are around the house.

George Washington designed this house. Some of his letters and other papers tell about the building of Mount Vernon. He built his house to last for many, many years. It is a graceful house, but it is built so that it is strong and steady. It is very well balanced.





This is a very modern house. You may not like the design of the house. Some people say that houses like this look too modern. They may like houses which look more like Mount Vernon.

Houses may look different, but their basic design is the same. Houses must be built so that they are well balanced. They must be made of strong, sturdy building materials.

Churches, business buildings, and houses may be built in different styles. They may have different kinds of decorations. However, they are alike because they have wide, steady bases.

People in all parts of the world have known how to build houses and bridges for a very long time. They discovered that anything they built had to be well balanced. The shape of a building must be such that it will not fall over easily.

SOMETHING FOR YOU

1. Furniture must be built so that it is well balanced. Examine the chairs, tables, and desks in your room. Why do they not fall over?

2. Has anyone ever said to you, "Don't lean back in that chair. You will fall over if you do"? Why will a chair not balance on two legs?

3. Examine the lamps in your home. Why do they not tip over easily? Floor lamps are often tall and narrow. You may wonder at first why they do not tip over. Notice the bases. Are they broad and flat?

4. Notice the goblets, tumblers, and cups on your table when you have your next meal. Are they so well designed that they do not tip over easily?

5. Have you ever really noticed the design of your school or of your house? Try to draw a picture of these two buildings. Then take a good look at them. Did you draw a good picture?

6. Is your school designed so that it is strong and sturdy? Is your house well balanced? Do you think these buildings were well planned before the builders began their work? Why?

Fair Days and Cloudy Days

Weather—What Is It?

"How hot it is today! I wish it would rain."

"The weather report is that there will be frost tonight. We'd better cover the tomato plants."

"I hope it will be nice weather tomorrow so that we can go to the beach."

Have you ever heard people say these things? It is the weather they are talking about. Many times the plans we make or the things we do depend upon the weather.

Day	Morning	Afternoon
Monday, May 8	Fair	Cloudy
Tuesday, May 9	Rain	Rain

Changes in the air around you are weather changes. These changes take place from day to day. Climates change, too, but climate changes take place over a period of many, many years. Changes in the air, or weather changes, take place from day to day.

If the air is cold and dry, we have cold, fair weather. If the air is warmer and moist, we have cloudy or even rainy weather.

No place on the earth has the same kind of weather all the time. A place with a cold climate may have some days which are very cold. Then the days are warmer. If we lived there, we would say that the weather had changed.

A place with a warm climate has some cool, rainy days. It also has hot, dry days. The weather in a warm climate changes, too.

Any place on the earth has the same kind of climate for hundreds of years. But its weather changes from day to day.

Should you like to keep a chart like this for two weeks to see how the weather changes in the place where you live?

Changes in the Air

All around our earth is a layer of air many miles thick. We breathe this air. We walk in it. Airplanes fly in it.

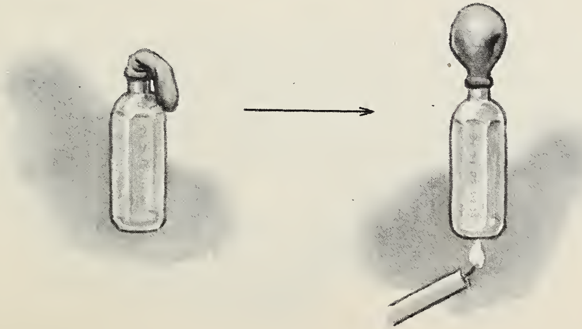
This air is a real thing. Even though we can't see the air, we can feel it when it moves. We can see leaves, flags, and dust being moved by air. But we cannot see the moving air.

The air is always pressing on our bodies. We do not feel the air or notice its pressure. Perhaps this is because we are used to air pressing on us.

Sometimes air presses more on us than it does at other times. Should you like to find out why this happens? If you would, try this experiment.

Air Expands

Fit a balloon over the mouth of a Pyrex bottle. Do not use a bottle which might break when it is heated.



Does the balloon hang limp? Now hold the bottle in both hands to warm it. Or you may warm the bottle with one or two candles. Move the candles around as you warm the bottle. If the bottle is heated too much in one place by a candle, it may crack. If you have an electric grill, put the bottle on it and turn the heat to "Low."

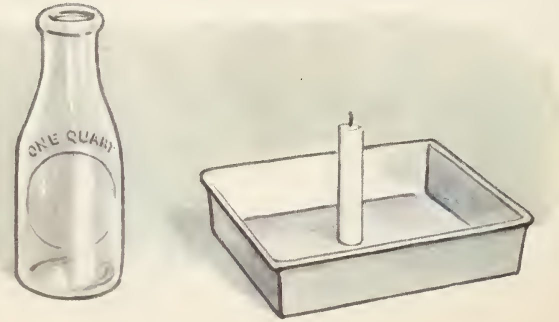
What happened to the balloon? What filled it so that it popped up?

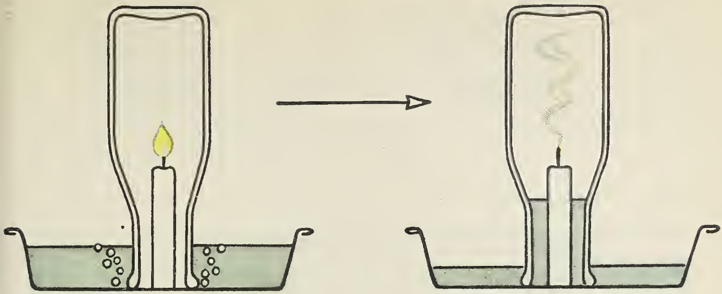
You know that no more air could get into the bottle because the balloon covered the opening tightly. Air must have gone from the bottle into the balloon.

Whenever air is warmed, it spreads out. We say that air expands when it is heated.

Here is another experiment which shows the same thing about air. You will need a metal pan, a candle, and a quart milk bottle.

Heat the end of the candle and set it in the center of the pan. Does the candle stick to the pan and





stand upright? Good. Now pour water in the pan to a depth of about two inches. Then light the candle.

Next, put the milk bottle over the candle. Watch what happens!

Why did the water rise in the bottle?

Yes, it was because some of the air in the bottle expanded and escaped. Did you see the bubbles come out of the bottle? This happened because the air inside the bottle was being heated. So the air expanded and came out of the bottle.

The air outside, in the room, was pushing down on the surface of the water in the pan. It pushed water up into the milk bottle to take the place of the air which had escaped.

Do you see how much air expanded and escaped from the bottle? Yes, just as much air escaped as there is now water in the bottle.

Here is another interesting thing about air. Suppose you had a cup full of cold air. The cup of cold air would weigh something. If you heated the air in the cup, the air would expand. Some of the air in the cup would escape. Therefore the cup of warm air would weigh less.

You could say this in another way. You could say that cold air presses down more, or has greater pressure, than warm air.

You could say that warm air presses down less than cold air, or that warm air has less pressure than cold air.

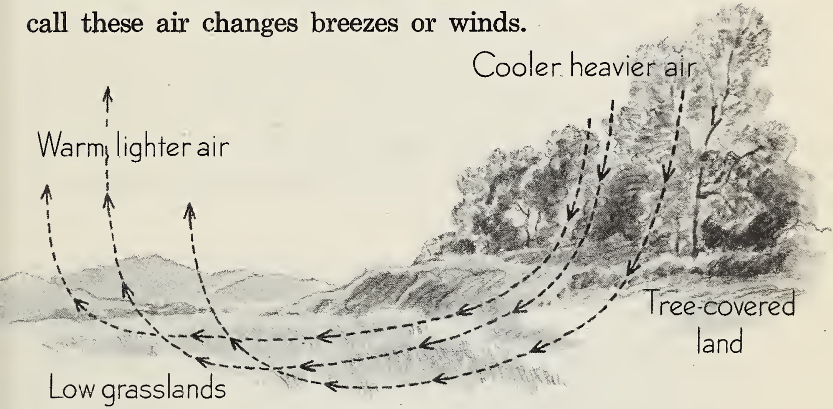
Air Moves About

Where should you expect air pressure to be greater — over warm earth or over cool earth?

Sometimes the sun warms parts of the earth more than it warms other parts. The air over these warmer places is warmed, too. The air expands. Each cup of air is lighter than it was before the air was warmed.

The air over the cooler places on the earth is cooled. It contracts, or comes together. Therefore it grows heavier. As you might guess, this cold, heavy air sinks toward the ground. As it sinks, it pushes the warm, light air aside and up.

This means that the air moves about from one place to another. Cool, heavy air moves down and pushes warm, light air up and out of the way. We call these air changes breezes or winds.



You have probably noticed that air can move about inside a room. Have you ever seen "heat waves" over a radiator? Perhaps you have watched dust moving upward over a radiator or stove. Warm air over the radiator or stove is being pushed up by cooler air. Have you ever seen dust moving up from a hot roadway in the summer?

Have you ever noticed that your father opens the damper on the furnace or in the chimney when he builds a fire? He opens the damper so that cool air inside the room will help to push the warm air over the fire up the chimney.

This draft, or current of moving air, makes the fire burn more brightly. After the fire is burning well, he turns the damper so that not too much warm air will go up the chimney.

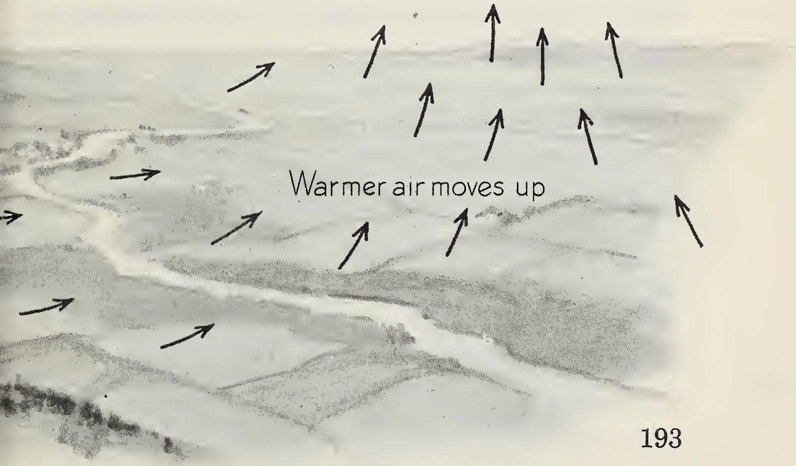
If you have learned to build campfires, you know that you must build the fire in a certain way so that it will burn well. You know that you must leave spaces between the sticks so that cooler air can move

along the ground and push the warmer air up in the center of the fire.

Do you see now that an air current, or draft, is air flowing from a place where the air is cooler to a place where the air is warmer?

If one great mass of air is very warm and another great mass of air is very cold, the cold air will rapidly push aside the warm air. Then the moving current of air will be strong. There will be a wind.

Suppose two great masses of air are more nearly the same temperature. Then the cooler air will push aside the warmer air more slowly. There will be a gentle wind or a breeze.



Water from the Air

Puddles dry up quickly when the sun shines after a storm. Wet clothes dry quickly on a bright, sunny day. They dry even more quickly if there is a breeze or a wind.

You know where the water goes from the puddles and the wet clothes. It evaporates. It goes into the air. We do not see water in the air around us, but it is there just the same.

Liquid Water from the Air

We think more about water in the air when it begins to come together in the air. First we see this water in the form of clouds. Then we see and feel the water droplets falling.

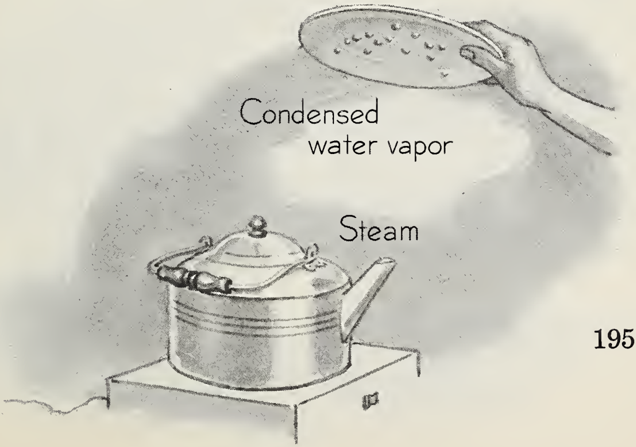
This experiment may help you to understand more about the way in which water gets out of the air in the form of rain.

Put some water in a teakettle or in a pan. Let the water boil. Do you see a white cloud above the pan or kettle? This is a cloud of water vapor. Warm, moist air is moving upward above the kettle. As this warmer air is cooled, the moisture condenses, or comes together. It forms a white cloud.

This white cloud is not steam. Steam is invisible. It is very, very hot. The steam is between the surface of the water and the white cloud that you see above the kettle.

Now hold a cold plate about one foot above the kettle or pan. Do drops of water collect on the plate? Moisture from the warm air has condensed in drops on the underside of the cold plate.

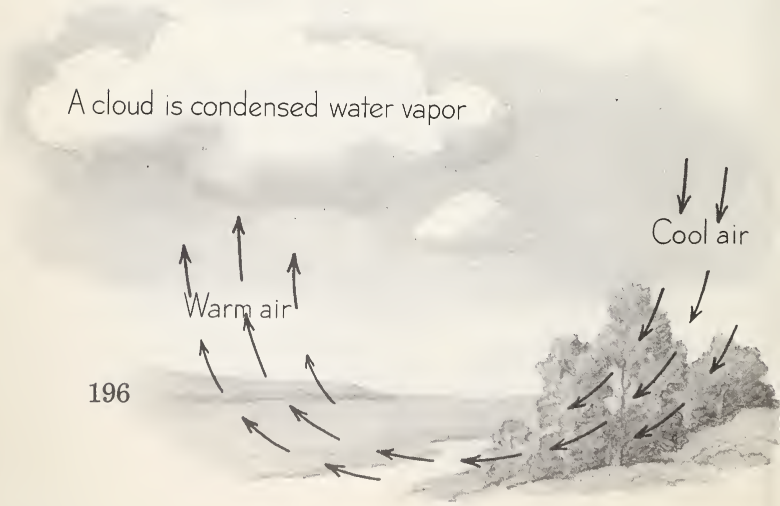
This same thing happens on the underside of the glass cover on your aquarium. Warm, moist air rises over the water in the aquarium. When this air



touches the cool glass top of the aquarium, the moisture condenses on the underside of the cover.

Have you ever seen drops of water on the inside of a windowpane? You usually see them there in cold weather. The water in the moist, warm air of the room condenses on the cold windowpane. Can you think of other places where the moisture from warm, moist air condenses when it comes in contact with cooler air?

Rain is formed in much this same way. You know that warm, moist air is pushed up by cooler air. The warm air is pushed up and up and up. As it is pushed up, it is cooled. Finally it is so cool that the water in the air condenses to form clouds. Drops of water may fall as rain from these clouds.


A cloud is condensed water vapor
Cool air
Warm air

Have you ever walked through dew-covered grass in the early evening? Have you ever seen morning sunlight glittering on a dew-covered spiderweb?

This dew does not fall, but it does come out of the air.

If you would like to see dew form, do this experiment. Fill a glass half full of ice. Then pour water in the glass. Do you see drops of water forming on the outside of the glass? Where did it come from?

Dew forms on grass and trees and bushes in this same way. In the evening the earth becomes cooler than the air around it. Then dew forms because the water vapor in the air condenses when the warm, moist air touches the cooler earth and things on the earth.

Frost is also water from the air. But frost is formed when the temperature of the grass or trees or bushes is at or below the freezing point of water.

As the water vapor condenses, tiny crystals are formed. Ice crystals are formed, instead of drops of water, because of the cold. The water droplets are frozen as they condense. These ice crystals are called frost.

Frost sometimes forms on your windowpane. It is always on the inside of the window. The windowpane becomes very cold. As the warm, moist air in the room touches the window, the water in the air condenses as tiny crystals of ice. These ice crystals form beautiful patterns like those in the picture.

Solid Water from the Air

Do you like to play in the snow? You may build snowmen, or you may play with your sled. When you play in the snow, you are playing in water just as much as when you go swimming.

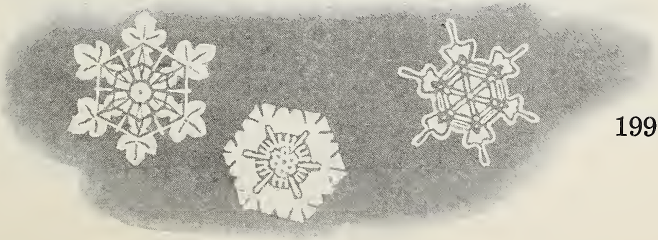
But you are not playing with liquid water. You are playing with little pieces of solid water. This solid water, or snow, has come out of the air in much the same way as rain.

The weather is cold when it snows. This means that the air above the ground is cold. The air is so cold that it is colder than the freezing point of water. As moisture condenses from the air, each tiny drop is frozen. Each of these tiny frozen drops of water is a snow crystal.

Sometimes these crystals fall separately. They have beautiful shapes. No two are ever just alike. At the bottom of this page are some snow crystals.

If you would like to see some of these beautiful snow crystals, catch some of them on a piece of dark cloth the next time it snows. You will have to do this when a fine, powdery snow is falling. Then you will be able to see each separate snow crystal. Usually one tiny snow crystal is added to another until a soft, big snowflake falls.

Snow acts as a blanket over the earth. It protects plants from the freezing air. And melting snow soaks into the earth and makes it moist.



Solid water may also fall to the earth as sleet. If the air between the clouds and the earth is very, very cold, raindrops or partly melted snowflakes may be frozen as they fall through the cold air. Sleet is hard, frozen water.

You may live in such a warm part of the country that you have never seen sleet or snow. But no matter where you live, you have probably seen hail. We usually have hailstorms only during hot weather.

Hailstones are formed in a most interesting way. They form when the air is in warm and very cold layers. This may happen when cold air is moving toward very warm air. The cold air may move to where you live on a very hot summer day.

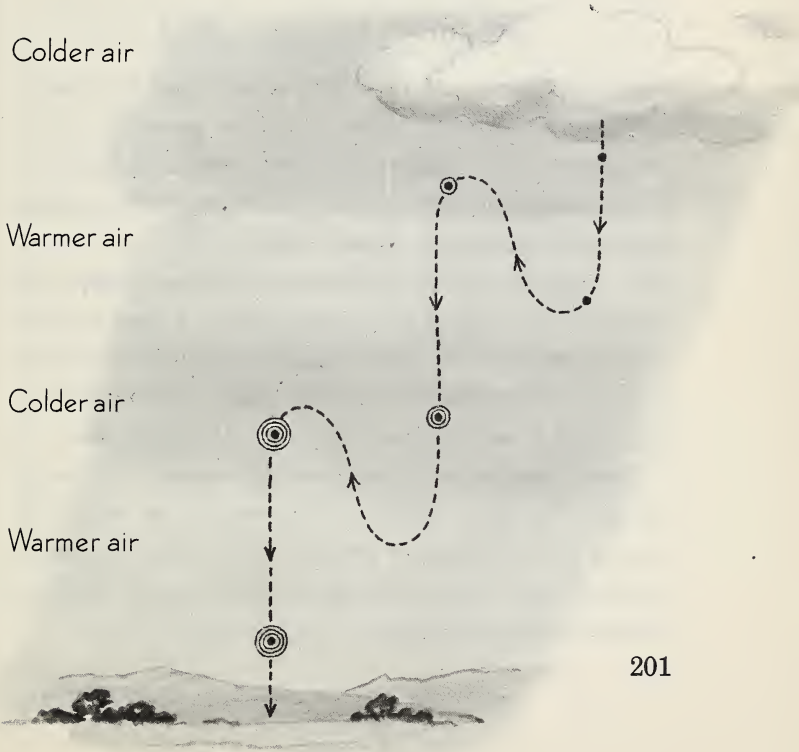
Water droplets may begin to fall from a cloud. When they fall into the layer of cold air beneath the cloud, they are quickly frozen. The small drops of frozen water are hailstones.

These small hailstones then fall toward the earth. They fall until they meet a layer of rising warm air. Moisture collects on the hailstones while they are in this layer of warmer, moist air.

A solid hailstone with its layer of moisture may be carried upward again by the rising warm air. It may be carried up and up into a layer of very cold air. Here the moisture on the outside of the hailstone is frozen. The hailstone has grown larger. Again it falls toward the earth.

Does the picture below help you to understand how a hailstone may be tossed up and down many times? Each time it goes through a layer of warm air, it collects moisture. Then this moisture freezes.

The hailstone grows larger and larger. Finally it falls all the way down to the earth.



Storms Come and Go

All of us notice the weather most when it is rainy or foggy or stormy. Sometimes we grumble about stormy weather, but we probably wouldn't like it if the weather were always clear and sunny. We might soon grow tired of such weather.

In most parts of the United States, there are usually several days of fair weather and then several days of stormy weather. This is because the air is always moving from west to east. A storm may come, but it will not stay forever. It moves on.

There may be whirlpools in this eastward-moving air, just as there are whirlpools in a river which is always flowing toward the sea. But there is always a steady movement of the air from west to east across the United States.

The air moves in from the Pacific Ocean across the United States and on out over the Atlantic Ocean. Can you trace this movement of the air on a map?

As you know, not all the air is the same temperature. Some great masses of the air are colder than others. The colder air is always moving toward the warmer air. It is always pushing the warmer air out of the way and upward. Clouds are formed, and rain or snow may fall from these clouds.

Sometimes in the spring and summer very warm air near the earth's surface is pushed up quickly. It is pushed up quickly by much cooler air from the west. Moisture in the warm air condenses out of the air to form dark clouds.

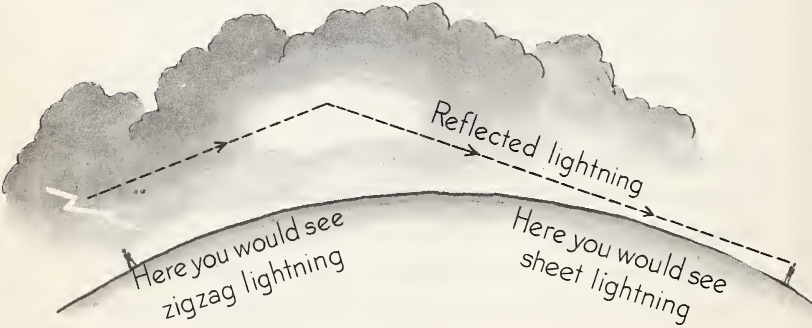
These huge, dark clouds are called thunderheads. They look as if they were boiling. They really aren't boiling. The wind is moving the water droplets around so much that the clouds seem to be boiling.

Often a long roll of thunder causes us to notice these clouds in the west. Soon we see lightning and hear more thunder. The storm is coming quickly. Very soon heavy rain begins to fall. Lightning and thunder may continue all through the storm.

The lightning is caused when a huge electric spark jumps from one cloud to another. Sometimes the electric spark may jump from a cloud to the earth.

This happens when you see "streak," or "zigzag," lightning strike a tree or building. Lightning is zigzag because electricity always travels in the easiest path. The easiest path through the air is almost never a perfectly straight path.

Sometimes you see "sheet" lightning, that is, a flash of lightning that seems not to zigzag. When this


Reflected lightning
Here you would see zigzag lightning
Here you would see sheet lightning

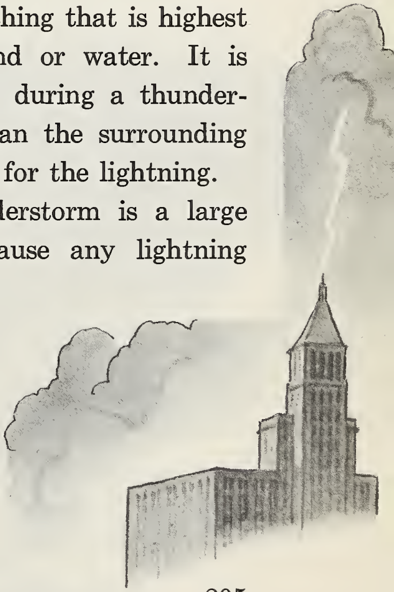
happens, the thunderstorm is so far away that you cannot see the zigzag lightning. You see only its reflection in the sky.

Lightning heats the air through which it passes. This causes the air to expand so suddenly that the expansion is like an explosion. We call the sound thunder. Some people may be frightened by thunder, but thunder cannot hurt you. It is only a noise.

Few people are ever hurt by lightning. However, it is well to know a few things about protecting yourself from lightning.

Lightning usually strikes the thing that is highest above the surface of the ground or water. It is dangerous to stay in swimming during a thunderstorm. Your head is higher than the surrounding water. You make a good target for the lightning.

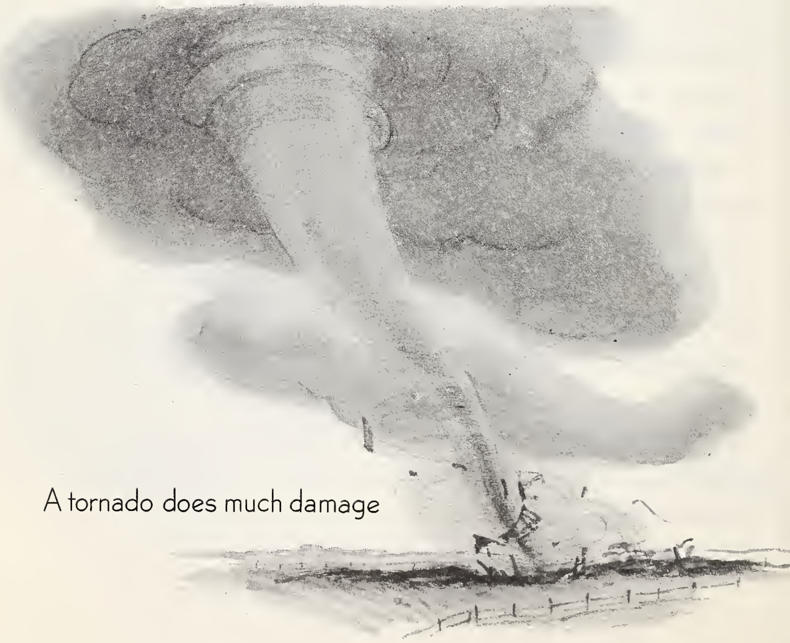
A safe place during a thunderstorm is a large modern building. This is because any lightning which strikes the building would not be likely to strike you. The steel part of the building would make a good path for the lightning. The lightning would go through the steel into the ground. You would not be hurt.



Big Winds

Some storms move very rapidly. Cold air pushes warm air aside with great force. Then we have high winds. At times these winds are so strong that we call them gales. Such winds may travel more than sixty miles in one hour.

There are storms at sea, just as there are storms over the land. These sea storms, if they are very bad, are called hurricanes. Hurricanes may do much damage to ships at sea. If hurricanes move over the



A tornado does much damage

land, they may blow down trees and houses. These are very strong winds indeed.

Tornadoes are strong winds, too, but they take place over a smaller area of the land than hurricanes. A tornado is a strong, twisting wind. It is caused by colder air moving warm air very, very rapidly over a small area.

When there is a tornado, trees are uprooted. Houses may be destroyed. Sometimes people are killed. We do not often have tornadoes. It is a good thing that we do not.

"Do you think it will be good weather?" "Do you think it will be rainy?" These are the weather questions which we often ask. When we ask them, we are asking about movements of the air and about whether or not water will come out of the air as rain or snow.

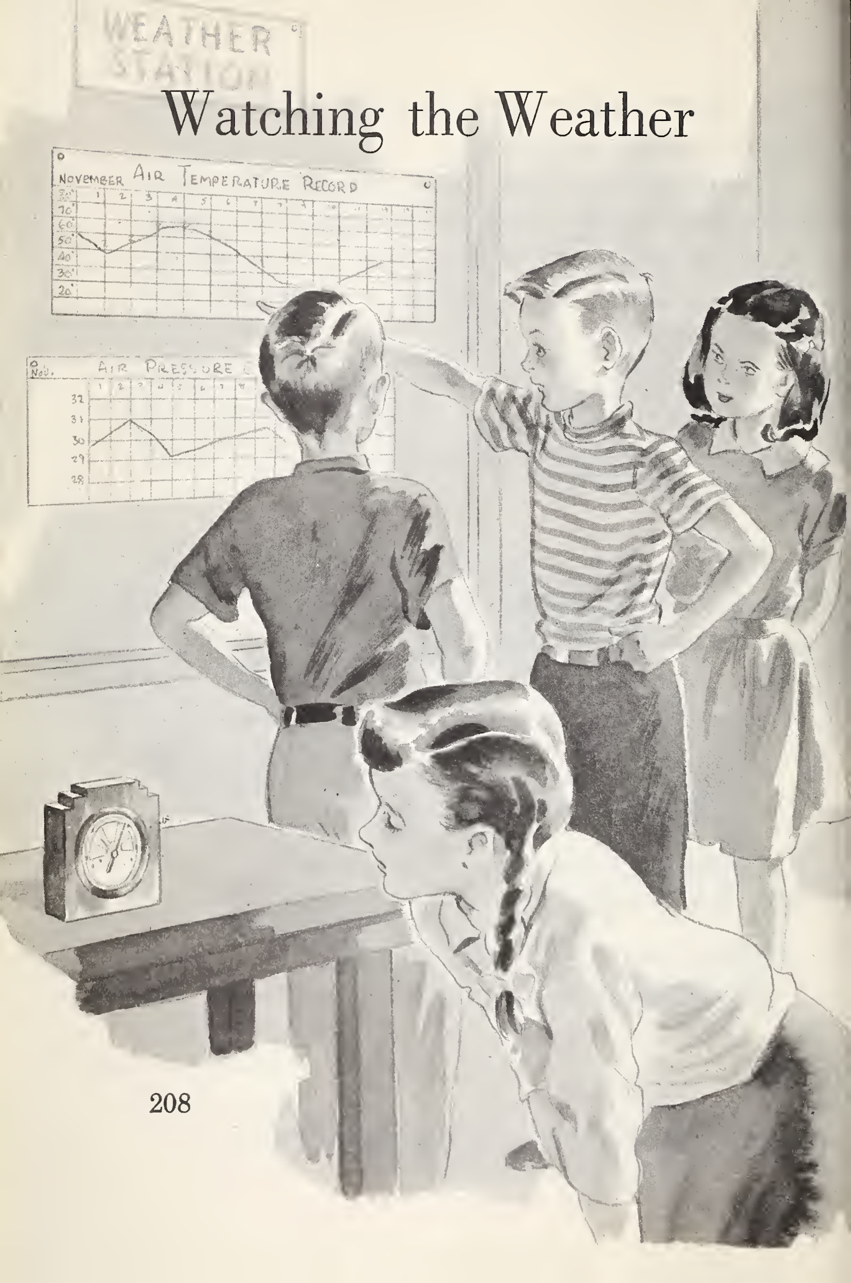
SOMETHING FOR YOU

1. Hold a pinwheel over a hot radiator or stove. Why does it whirl around?

2. Why does smoke rise?

3. Do weather changes make you feel different? Do you feel full of pep on a cool day? Do you suppose animals feel weather changes, too?

Watching the Weather



The Weather Today and Tomorrow

It is easy to tell what the weather is today. All you need to do is to look out of the window and see what is happening. You can tell whether it is fair or cloudy or rainy weather.

Trying to tell what the weather will be tomorrow is harder. Should you like to try to learn to tell something about what the weather will be tomorrow?

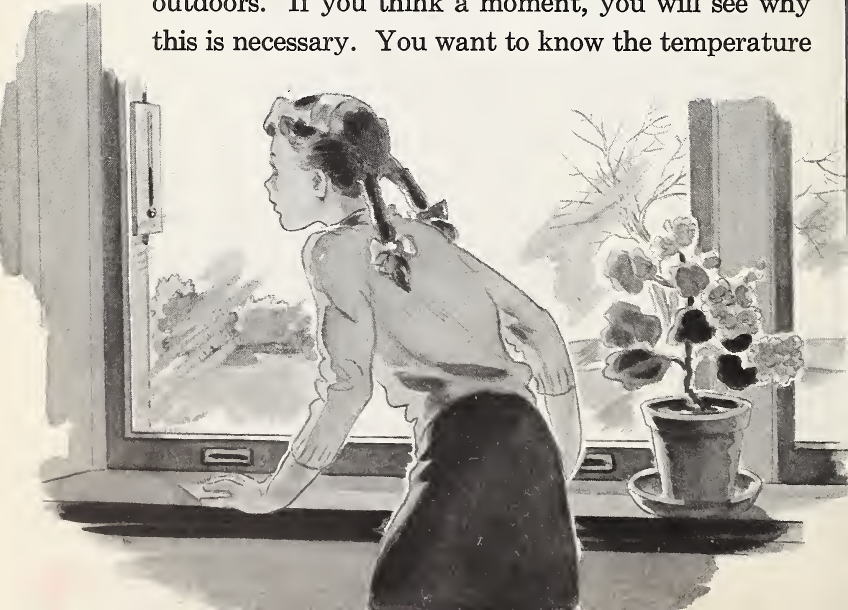
Telling about the weather tomorrow is called forecasting the weather. A weather forecaster is a trained weather observer. Of course you will not be able to forecast the weather as accurately as a trained weather forecaster. However, you will be able to find out some interesting things about the weather.

Here are some things you will need to observe as you try to forecast the weather:

Temperature of the outside air
Changes in air pressure
Speed of the wind
Direction of the wind

Air Temperature

The thermometer which you use should be placed outdoors. If you think a moment, you will see why this is necessary. You want to know the temperature

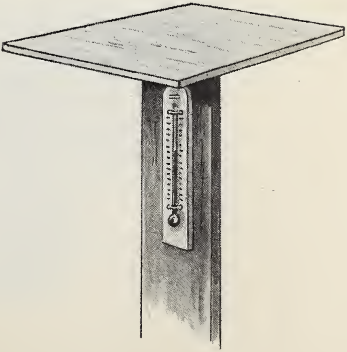


of the outside air. The inside air may be heated by radiators or stoves. The temperature of the outside air is the temperature that you will need to help you in weather forecasting.

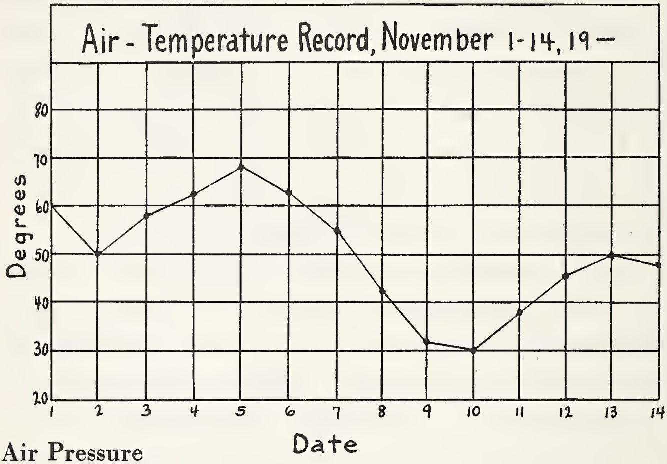
You might like to fasten your thermometer just outside a window. If you do this, be sure to read the thermometer when it is in the shade. If the sun is shining on the thermometer, the temperature will be higher than the real temperature of the air around the thermometer. Since you need the temperature of the air, you must use a shaded thermometer.

If it is possible, you might build a special place for your thermometer outside in the schoolground. This would be a better place for your thermometer, since air coming from any direction could touch it. This thermometer would have to be shaded, too.

This is the way some children built a temperature station in their schoolyard: The father of one of the children helped them to drive a sturdy post about five feet high into the ground. The children nailed a wooden cover two feet square on top of the post. The thermometer was put on the post about six inches below the cover. In this way it was protected from the sun.



The children kept a record of the temperature for two weeks in November. Their record looked like the one on this page. You might think of a better way to keep your air-temperature record.



Air Pressure

You know that air pressure changes. During warmer weather the air expands, so that it presses less on us. During colder weather the air contracts, or comes together. Then the air presses more on us.

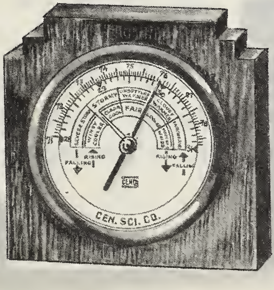
If colder weather is coming, the air pressure becomes greater. If warmer, more moist weather is coming, the air pressure becomes less. Your body cannot feel these changes in air pressure, nor can you see them.

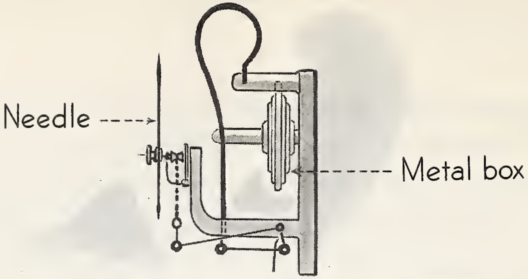
Changes in air pressure are measured by a barometer. It is not necessary to keep a barometer in the outside air. There are many little air spaces around the windows and under the doors of a room. The air pressure changes inside, as well as outside, a room.

Good barometers are rather expensive to buy; so you might try to borrow a barometer. The kind of barometer that people usually have in their homes is called an aneroid barometer. The girl in the picture on page 208 is reading an aneroid barometer.

Perhaps you would like to know how an aneroid barometer works. Below is a front view of an aneroid barometer. Notice the words and the numbers on the barometer. Do you see "Fair," "Unsettled," and "Storms"?

As you watch an aneroid barometer from day to day, you will see that the needle of the barometer usually is in a different place each day. If the needle moves from "Fair" to "Unsettled," the weather will probably soon be cloudy. It may even rain.



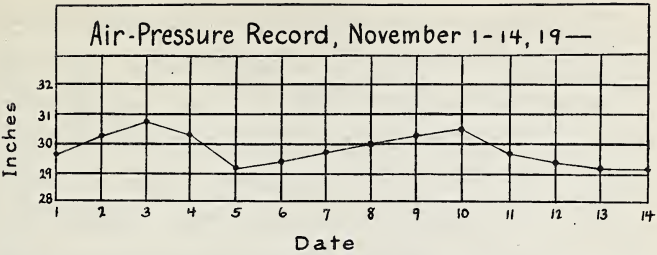


Now you may be wondering just why the black needle of the aneroid barometer moves from one place to another. It moves because of changes in the air pressure.

Above is a drawing of the working parts of an aneroid barometer. This is a side-view drawing. Behind the needle and dial of the barometer is a small metal box. There is very little air in this box. Therefore it can be pressed together very easily.

Suppose the air pressure in the room becomes greater. What do you think will happen to the metal box? Yes, the sides of the box will be pushed together a little. When this happens, the black needle, which is attached to the box, moves to the right. When the air pressure becomes less, the sides of the box move outward a little. This causes the needle to move toward the left.

When the needle of the barometer moves to the right, we say the barometer is rising. When the needle moves to the left, we say the barometer is falling.



There are some numbers on the dial of the aneroid barometer, too. These numbers give the air-pressure reading in inches. You know that air presses on us. Sometimes the air pressure is enough to push a column of mercury up in a tube to a height of 31 inches. Then we say the air pressure is 31 inches.

At other times the air pressure is able to push the mercury up to a height of only 30 inches. Then we say the air pressure is 30 inches.

When the needle on your aneroid barometer points to 30, the air pressure is enough to hold mercury up to a height of 30 inches. If the air pressure increases, the needle will move toward 31.

Perhaps you would like to keep a barometer record. This is a chart that one group of children kept for two weeks. The numbers across the bottom of the chart are for the days in November. The numbers down the left side give the air pressure. Compare this chart with the air-temperature chart on page 212.

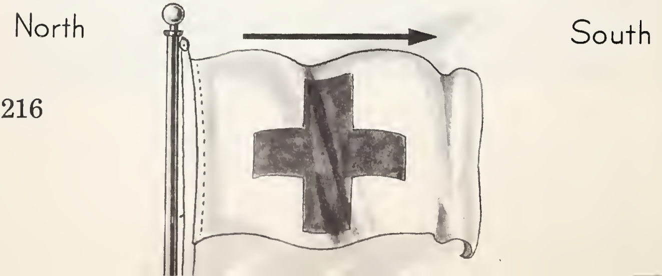
If you look at the temperature chart and the air-pressure chart which the children kept, you may notice something important. Do you see that the air is warmer when the air pressure is less? Do you see that the air is colder when the air pressure is more?

This will probably be true of your records too. You know that warmer air is expanding air. This means that the air pressure is less. Colder air is contracting air; so the air pressure is more.

Air-pressure information should help you to forecast the weather. If the pressure of the air is becoming less, this means that the weather will be warmer and more moist. It may even rain or snow. If the pressure of the air is becoming greater, the weather will probably be cooler or even cold. It will also probably be clear. Try to tell what the weather will be tomorrow.

Air Movements

Another interesting thing to notice about the air is the direction in which it is moving and the speed at which it is moving.



You will find that it is easy to tell the direction of the wind. Watch a flag on a tall building or on a pole in an open space. The flag will blow with the wind.

If the flag is blowing toward the south, then we know the wind is blowing from the north. It is a north wind. If the flag is blowing toward the east, then we know the wind is blowing from the west. It is a west wind.

Here is a table which may help you to tell the speed of the wind. This table was adapted from a wind scale made by a scientist named Beaufort.

CALM Leaves on trees are still No wind blowing	
GENTLE WIND Leaves just move Speed about 10 miles an hour	
MODERATE WIND Branches of trees move; dust blows Speed about 20 miles an hour	
STRONG WIND Trees blow back and forth; hard to walk Speed about 35 miles an hour	
STORM Tree branches are broken; wind does damage Speed from 45 to 100 miles an hour	

Daily Weather Record, April 23 - May 6, 19—

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Air temperature	65°	60°	45°	55°			
Air pressure	Low	Medium	High	Medium			
Sky condition	Cloudy	Partly cloudy	Fair	Fair			
Rain or snow	Rain	None	None	None			
Wind direction	N.E.	W.	S.	S.W.			
Wind speed	Moderate	Moderate	Gentle	Gentle			
Air temperature							
Air pressure							

Now you might like to keep a more complete weather record. It should show air temperature, air pressure, sky condition, rain or snow, wind direction, and wind speed. Do you now know how to find out all these things about the air?

Try to make some weather forecasts after you have watched the weather for about two weeks. See how often you are right in your forecasts.

Weather Stations

This is a weather station. The man is watching a balloon to find out about wind currents. The balloon is floating freely in the air. The man will watch it very carefully to see which way it moves.

Inside the little house is a thermometer. Air can get to the thermometer, but the thermometer is protected from the direct sunlight.

Up on the tall pole are two very important instruments. At the very top of the pole is a wind vane. This instrument gives the direction of the wind. The other instrument is an anemometer. An anemometer tells the speed of the wind.

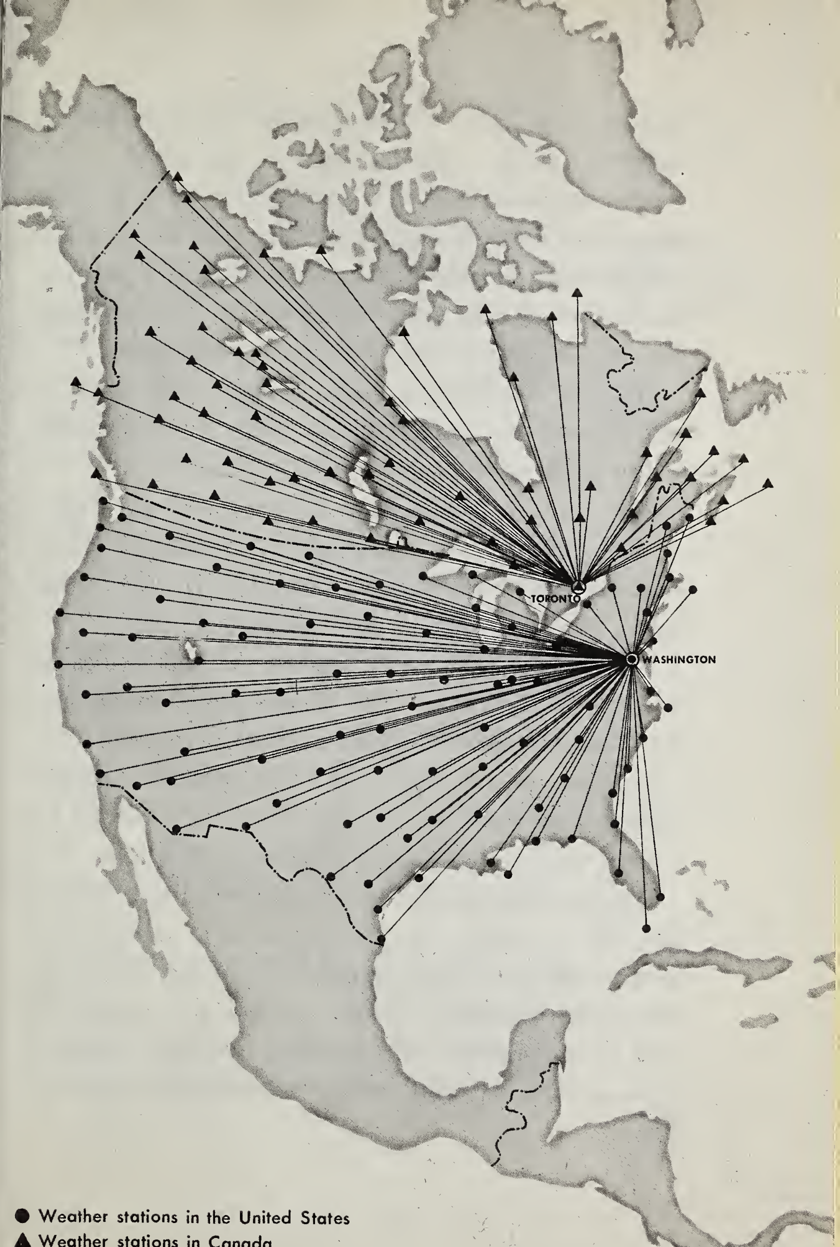
There is a barometer at the weather station, too. This barometer is usually kept inside because the pressure of the air changes inside, as well as outside.

Weather stations also have instruments which tell about the water in the air. One of these instruments shows how moist the air is. Another shows the amount of rain, snow, or sleet which falls.

All these instruments are important because they tell about these things:

Direction of the wind
Speed of the wind
Temperature of the air
Pressure of the air
Amount of moisture in the air
Amount of rain or snow or sleet

Weather stations may be on the tops of mountains where men watch the weather even during the coldest months of the year. Some weather stations are in cities on the tops of tall buildings. Some are on



● Weather stations in the United States
▲ Weather stations in Canada

college campuses. Other weather stations are in valleys or in the very dry parts of the world.

Men and women all over the world work in weather stations so that we may know what the weather will be. Weather reports from these stations are given to newspapers so that we can read the weather forecast. Weather reports are also given over the radio.

Weather records are made at the same times of day all over the United States. This is usually done in the early morning and late afternoon.

The weather information in these records is sent by telegraph to larger stations. Then these stations send the information on by telegraph to the United States Weather Bureau at Washington, D.C.

In Canada the central weather bureau is located in Toronto, Ontario. The Washington bureau and the Toronto bureau exchange weather reports.

As the reports come in from smaller stations scattered all over the country, they are recorded on a large map of the United States and Canada.

Weather information is not always written out on the map in words. People interested in the weather have made up certain signs, or symbols, which tell about the weather. These symbols are sometimes used on a weather map because they take up less room and because they can be read easily and quickly.

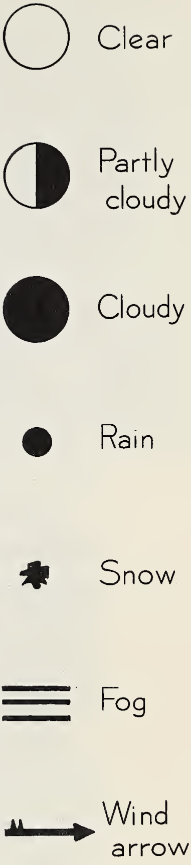
Some of the symbols which are used are shown along the side of this page. These symbols tell whether the day is clear or rainy or cloudy. They tell of fog or snow.

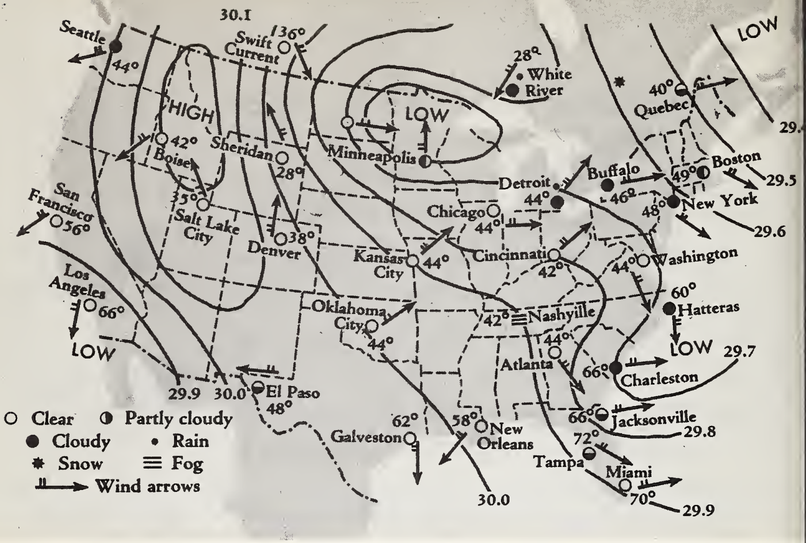
An arrow may be near these symbols to show the direction of the wind. As you know, winds blowing from the east are east winds. Winds blowing from the west are west winds. Could you tell how the wind you are having today would be recorded on a weather map?

The arrow of a wind symbol points in the direction in which the wind is blowing. Look at Galveston and El Paso, Texas, on the weather map on the next page. The wind arrow at Galveston is pointing in the direction in which the wind is blowing; so Galveston is having a north wind.

Find your city or a city near where you live. In which direction was the wind blowing in your city on the day the map was made?

Beside the wind symbols you see numbers like these: 62° and 40°. These numbers tell the temperature of the air. On other days the temperature numbers will be different.





Then there are some curved black lines on the weather map. These lines tell about air pressure. All the cities which are near one another and which report the same air pressure are connected by a black line. The air pressure reported by those cities is shown at the end of the line.

Find New Orleans, Oklahoma City, Denver, Sheridan, and Swift Current on the map. The same black line runs through all these cities. This means that these cities reported the same air pressure on this particular day.

The words "High" and "Low" show the centers of the high-pressure and low-pressure areas. The high-pressure and low-pressure areas move across the country from the west to the east. They move in this way, you may remember, because air moves from west to east across the United States.

Weather forecasters know that the high-pressure and low-pressure areas move in this way. They estimate the speed at which the air is moving. Then they know about when to expect a high-pressure or a low-pressure area to arrive where they are.

Of course these weather reporters know that a low-pressure area is usually one of cloudy, often rainy and warmer, weather. They know that a high-pressure area is usually one of clear, sunny, and cooler weather.

Do you see Minneapolis on the weather map? It is at the center of a low-pressure area. It is partly cloudy there. But the weather man in Minneapolis would be able to forecast the weather by looking at this map.

A high-pressure area, bringing fair, cool weather, is moving toward Minneapolis. The forecaster knows how fast this air is moving, and so he knows when to predict fair, cool weather.

Weather forecasters are not always able to tell exactly what the weather will be. However, they are usually fairly accurate in their forecasts.

Using Weather Reports

The telephone rings many times during the day at the weather station. People want and need accurate weather information.

It is Friday morning in the summer. The bakers need to know what the week-end weather will be.

If it is warm and sunny, many people will go into the country or parks on picnics. This means that they will need sandwiches. The bakers need to know if the week end will be fair. If it is going to be fair, they will bake an extra supply of bread.

Weather stations are especially useful along the seacoast. They give out storm warnings. These warnings are read over the radio. Flags which mean that a storm is coming are flown at the harbors. Fishermen will not go out to sea in their small boats when they see these flags.

The weather station warns of floods, high winds, frosts, and other conditions that might cause damage. Weather reports help you in planning an automobile trip. In what other ways are weather reports used by people in your neighborhood?

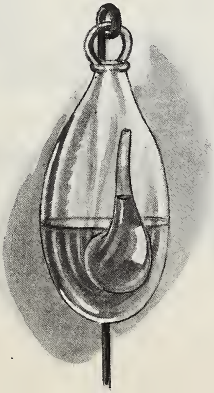
Don't you think that the people who read weather reports from all over the country and make weather forecasts are important community helpers?

SOMETHING FOR YOU

1. Weather stations are found not only in North America, but all over the world. Weather forecasts are sent from one country to another every day. Why do you suppose this is done?

2. Scientists who are interested in the weather are always working on ways of forecasting weather more accurately. Aviators make flights several miles high to make air-pressure and temperature records. They do this because it is thought that any air changes high in the air may have a great deal to do with air changes nearer the ground. Watch your newspapers for more about this. Man is learning more and more about the weather.

3. Have you ever seen a barometer that looks like this? Sometimes such a barometer is called a swan-neck barometer; sometimes it is called a Cape Cod barometer. The liquid in it is water. Try to explain how it works.



About Magnets

Making Magnets

Have you ever played with magnets? You probably have. You may even own a magnet. Does your magnet look like one of the magnets that the children are playing with in this picture?

One of the children is playing with a horseshoe magnet. Another child is playing with a bar magnet. A third child is playing with a U-shaped magnet. Try to find each of these magnets.

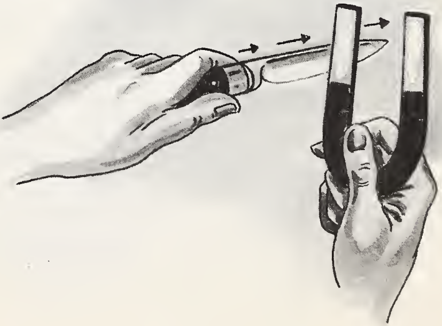
A part of a compass is a magnet. If you have a compass, you probably know which part of it is a magnet. Bring your compass to school, so that other children will be able to see how it works.

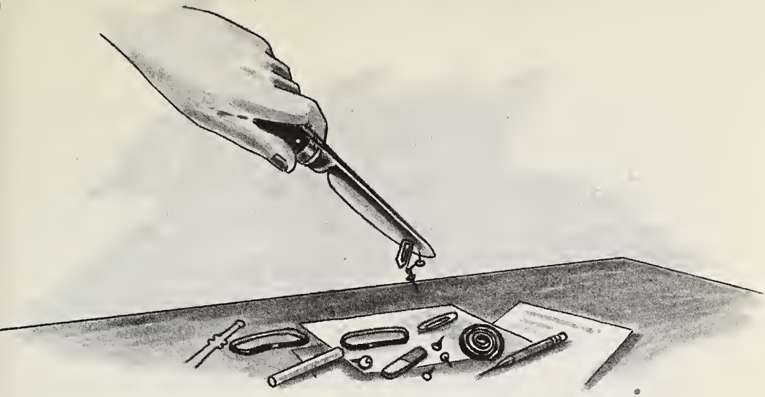
Perhaps there is only one magnet for all the children in your room. It would be easy for everyone to have a magnet. You can make other magnets if you have a magnet to begin with.

If you want to make a magnet, you will need something made of iron or steel. The iron or steel object may be made into a magnet. You might like to magnetize a large nail, a steel knitting needle, or your knife blade.

This is the way to make a magnet of the iron or steel object which you have. Just stroke the nail or knife blade with a fairly strong magnet. Be sure to stroke the nail in the same direction each time.

Lift the magnet away from the knife blade at the end of each stroke. Then stroke the blade again in the same direction. Do not rub the magnet back and forth along the knife blade. If you do, you will not be able to make a strong magnet.





Test your nail or knife to see if it is a magnet. Try to pick up small nails or tacks with it.

Collect some things which are not made of iron or steel. Get small pieces of chalk, small pieces of wood, some rubber bands, and some small pencils. Put them in a pile on the table.

Will your magnet pick up any of these things? Now add tacks, paper clips, and small nails to the pile of objects. Which things will your magnet pick up?

Isn't it a good thing that all objects cannot be picked up by a magnet? What a hard time we should have trying to keep objects separated! If cloth were magnetic, it would be difficult to make a bed. If paper were magnetic, you would have a hard time turning these pages. If our shoes were attracted by the sidewalk, walking would be quite a problem!

If your magnet is strong enough, you can make a "string" of small nails. Put one nail on the end of your magnet. Then hang another nail on the first nail, still another on the second nail, and so on. Do you have a "string" of nails like the one in the picture below?

Now hold the top nail and remove the magnet very carefully. Do the nails stay together for a few moments? Each nail was a magnet for a little while. The nails "borrowed" some magnetism from the magnet.

Pieces of iron, such as nails or tacks, sometimes become magnets if they are left close to a strong magnet. They borrow magnetism.

Now you know two ways to make magnets. A piece of iron can be stroked with a magnet until it becomes magnetized. Nails or tacks which are near a magnet for a while will also become magnetized. A nail left near a strong magnet for a few weeks will become a fairly strong magnet.

Why Is It a Magnet?

Could you, by just looking at these nails, tell which of them is a magnet?

No, you probably couldn't. You would have to test the nails to find out which of them is a magnet.

The nails do not look different. But we know that if a nail is a magnet, it will act in a very different way from a nail that is not.

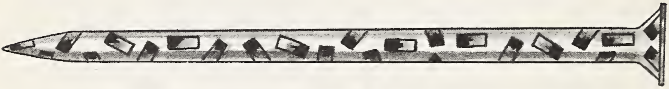
Here is an explanation that some scientists have given us about what happens to objects when they are magnetized. They do not know whether this explanation is true or not. However, this explanation has been useful to them in their work.

Everything is made up of tiny particles. A large piece of iron is made up of tiny pieces of iron. Each tiny piece of iron is called an iron molecule. A large piece of steel is also made up of tiny particles, or molecules.

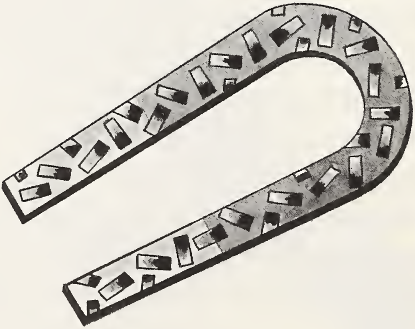
All things are made up of these tiny, tiny particles called molecules. Each molecule is very, very small—so small that you could not possibly see one.

When millions of iron molecules are put together, we might have a nail or a tack.

Each molecule of iron is thought to be a little magnet with a north end, or pole, and a south end, or pole. These molecule magnets are so tiny that they cannot be seen even with a microscope. Imagine that these are the molecules in an unmagnetized nail.

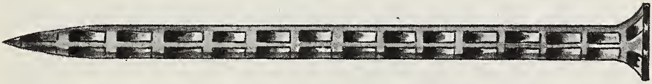


This might be the way that the iron molecules would look in an unmagnetized horseshoe magnet.

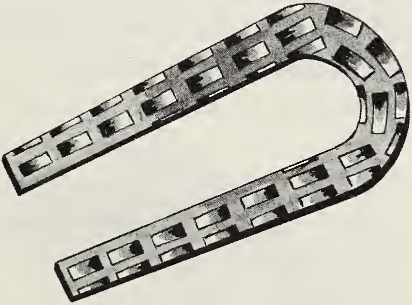


Could you think what might happen to the iron molecules if you stroked the nail with a magnet? It is very strange to think that the tiny bits of iron of a solid nail can move around. However, scientists tell us that such a thing might happen.

We think that the molecules in a magnetized nail would then be arranged in this way.



Then this would probably be the way the iron molecules would look in a strong horseshoe magnet.



Scientists think that the molecules in a nail become differently arranged when the nail is stroked with a magnet. The molecules are all in disorder at first.

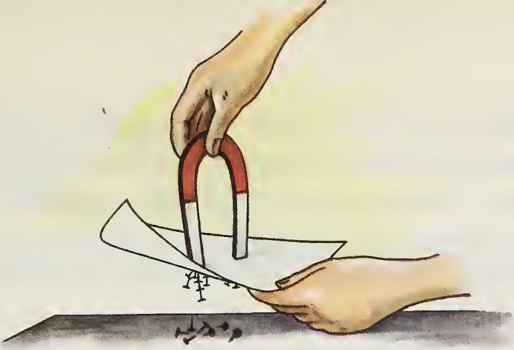
As the magnet passes over the molecules, their positions change. After a while the north poles of all the molecules point in the same direction. All the south poles point in the opposite direction.

If anything disturbs this arrangement of the molecules, we have our ordinary unmagnetized nail again.

This, then, is the explanation of how we think a magnet works. Perhaps someday we shall have a better explanation of just what magnetism is.

Magnetism Goes through Things

Hold your magnet just above some small tacks or iron filings. Do the tacks or filings jump up to the magnet? You do not have to touch the tacks with the magnet to cause them to move.



The magnetism is powerful enough to pull the tacks or filings up through the air to the magnet.

Magnetism is strong enough to pass through many things. Hold a piece of stiff paper between the tacks and your magnet. Does the magnetism pass through the paper? It seems that the magnet is trying to pull the tacks right through the piece of paper.

Try holding a piece of glass or copper or zinc between the tacks and the magnet. Do the tacks try to jump to the magnet? Magnetism passes through copper, zinc, and glass too.

Next hold a piece of a tin can between the magnet and the tacks. The tacks are not pulled up to the magnet, but the tin can is pulled up. It is held tightly to the magnet.

A piece of tin can is attracted by a magnet because it is made mostly of iron. A tin can is really an iron can with a very thin covering of real tin. Iron will not allow much magnetism to pass through.

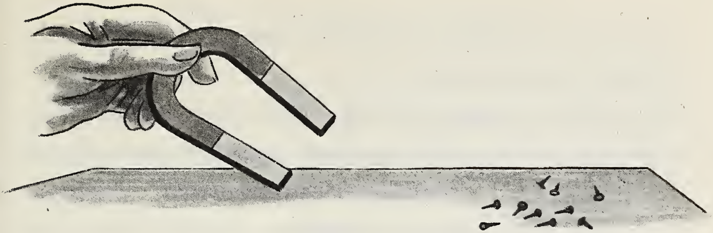
Scientists do not know why this is true. It may be that magnetism is used up in magnetizing the piece of iron. There may not be enough magnetism left to pass through the iron and attract the tacks. We may not know why these things happen, but we do know that magnetism will pass through paper. It will also pass through cloth, thin wood, and glass, and through copper, aluminum, brass, and most of the other metals.

Will magnetism pass through water? Put some tacks in the bottom of a pan of water. Lower the magnet into the water. Do the tacks jump up through the water to the magnet?

Wipe the magnet off carefully when you have finished. Magnets will rust, just as other pieces of iron and steel will rust.

Around a Magnet

Put some tacks at one end of a large table. Put your magnet at the other end of the table.



Are the tacks pulled all the way across the table by the magnet? No, they probably are not. You will find that you will have to put the magnet much nearer the tacks if they are to be pulled toward the magnet.

We say that an object is within the field of a magnet if the magnet attracts the object. A magnetic field is the space around a magnet, but it is only a special part of that space. It is the space within which iron or steel is attracted to the magnet.

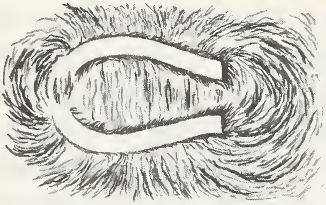
All magnets have fields. In other words, there is a place where a very small piece of iron will no longer be attracted to your magnet. The field of your magnet ends where that place begins.

A very strong magnet has a larger field than a weak magnet. The strong magnet can attract objects which are farther away from it.

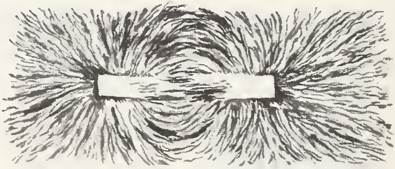
Should you like to find the size of the magnetic field of your magnet?

Lay your magnet on the table. Place a stiff piece of paper over it. Now sprinkle iron filings on top of the cardboard. Tap the cardboard gently.

If you are using a horseshoe magnet, the iron filings will make a design like this.



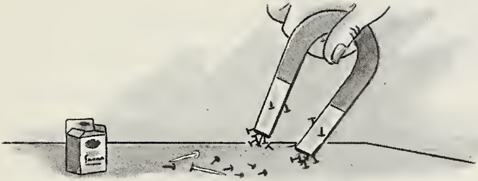
If you are using a bar magnet or a magnetized nail or steel knitting needle, the design will look like this.



Around the edges of the cardboard are some filings which are not attracted by the magnet. These bits of iron are outside the field of your magnet.

The Poles of a Magnet

Put a pile of nails and small tacks on a table. Lay a magnet in this pile of tacks and nails. Pick up the magnet. Are there more tacks near the ends, or poles, of the magnet than at any other place?

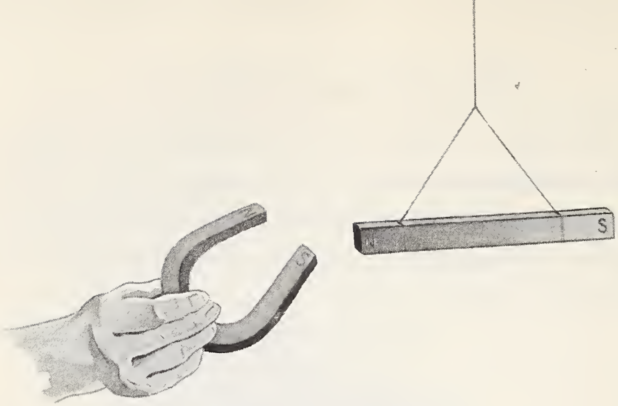


Take all the tacks and nails off the magnet. Try the experiment again. Does the same thing happen?

Now you know something very important about the poles of a magnet. You know that the poles are stronger than any other part of the magnet.

Each end of a magnet has been given a name. One end is the north pole. The other end is the south pole. If you tie a bar magnet so that it can swing freely, you will find that it will settle down with one end pointing north. The other end will point south.

The end which points north is called the north pole of the magnet. The end which points south is called the south pole of the magnet.



Tie a bar magnet in this way. Now bring the end of another magnet near the swinging magnet. Does the south pole of the magnet in your hand attract the north pole of the swinging magnet?

What happens when you bring the north pole of the magnet in your hand near the south pole of the swinging magnet? Are the poles attracted to each other? Each time, the north pole of one magnet is attracted to the south pole of the other magnet.

Now try this. Bring the north pole of one magnet near the north pole of the other magnet. Does the magnet swing away? What happens when you bring two south poles near each other? Yes, only poles which are not alike will attract each other. Only south and north poles are attracted to each other.

Magnets Show the Way

Have you ever used a compass? If you have, you know that it helps you to tell directions. This is because there is a needle in the compass which points north and south.

The compass needle is a small bar magnet which can turn around. This needle is affected by any iron or steel object which may be near it.

When you use your compass, be sure that it is not near iron or steel things. If it is, the iron or steel objects will attract the compass needle so that it will not point north and south as it should. It will point only to the iron or steel objects. This would not help you to know where north is.

People have known about compasses for a long time. The Chinese are supposed to have discovered that magnets could be used to tell direction.

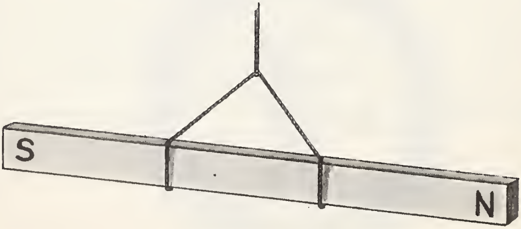
However, other people say that the Arabs, the Greeks, the Finns, or the Italians may have discovered this fact. No one really knows who discovered that magnets could be used as compasses. But we do know that all these people used compasses a long time ago.

Compasses were used in early days by people who lived on the shores of the Mediterranean Sea. These people who used compasses were traders and carried goods back and forth in ships. These sailing people found compasses very useful.

Long voyages were not often made before the compass was invented. The compass aided Columbus in his discovery of America.

Perhaps you would like to make a compass. If you would, hang a bar magnet by a string so that it will swing freely. Or you might use a strongly magnetized knitting needle for this. Then let the magnet come to rest. Be sure that wind cannot move the magnet around.

Do you know which is the north side of your room and which is the south side of your room? Ask your



teacher to check these directions with you. Does one end of the hanging magnet point north? Does the other end point south?

The north pole of your magnet should point north. The south pole of the magnet should point south.

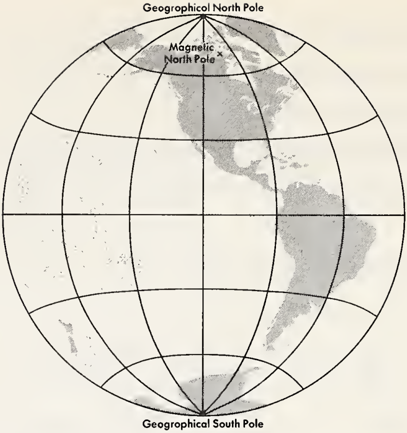
Are you now able to find all four directions — north, south, east, and west?

A Very Large Magnet

Why does a compass needle point north and south? The reason is that the earth itself is a huge magnet. We do not know just why the earth is a magnet. But we do know that the earth has a north magnetic pole and a south magnetic pole.

These magnetic poles are different from the true north pole and the true south pole of the earth. Look on your globe of the earth and find the true north pole and the true south pole. These true poles of the earth are also called geographical poles.

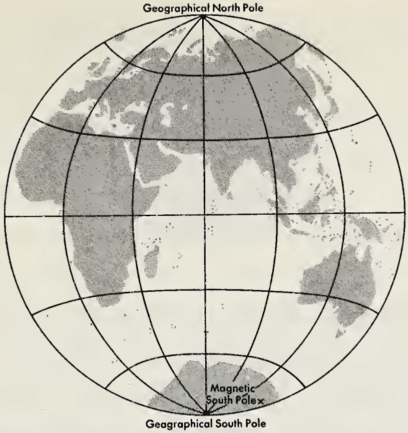
For a great many years people did not know that the earth had two different sets of poles. People knew that the earth was turning on its axis. They called the ends of this axis the north and south poles. They also thought that a compass pointed to these same poles of the earth.



However, as people used the compass more and more in exploring the earth, they began to feel sure that there were other poles. Sir James Clark Ross discovered the earth's north magnetic pole in 1831. He and the members of his expedition found the north magnetic pole to be in northern Canada.

The magnetic north pole is about twelve hundred miles from the geographical north pole. As you can see from the map above, the magnetic north pole is northwest of Hudson Bay in Canada.

Sir Ernest Henry Shackleton was exploring in the south polar region from 1907 to 1909. During his explorations he discovered the earth's south magnetic pole to be in Antarctica.

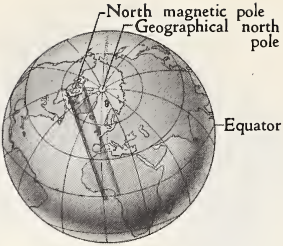


The south magnetic pole is over a thousand miles from the true, or geographical, south pole of the earth. The south magnetic pole is located almost directly through the earth from the north magnetic pole.

As you can see from the map above, the south magnetic pole is located very near one edge of the antarctic continent.

At most places on the earth, a compass does not point to the true, or geographical, north pole. The compass needle always points to the earth's magnetic north and south poles.

Look at the map on the opposite page. Pretend you are in Florida. Your compass needle would point toward the north magnetic pole. It would also



point to the true north pole because the two poles are in almost a straight line from Florida.

Now suppose you are in Alaska. Your compass needle would point to the north magnetic pole. But it would not point to the true north.

This fact confused sailors for a long time. Captains of ships have charts which have been worked out to show the location of the true north pole if the location of the magnetic north pole is known.

Scientists do not know exactly why the earth is a magnet. They do have explanations, or theories, about why the earth is a magnet.

Perhaps the best theory is the one which explains that the earth is magnetic because it rotates, or spins, on its axis. The rapid rotation of the earth has caused the molecules to be disturbed.

Then the molecules of iron within the earth have become lined up in one direction. They have been lined up because the sun is a huge magnet. The sun's magnetism has caused iron molecules within the center of the earth to line up.

This lining up of the molecules within the earth has caused the earth to have two magnetic poles. This makes the earth a huge magnet.

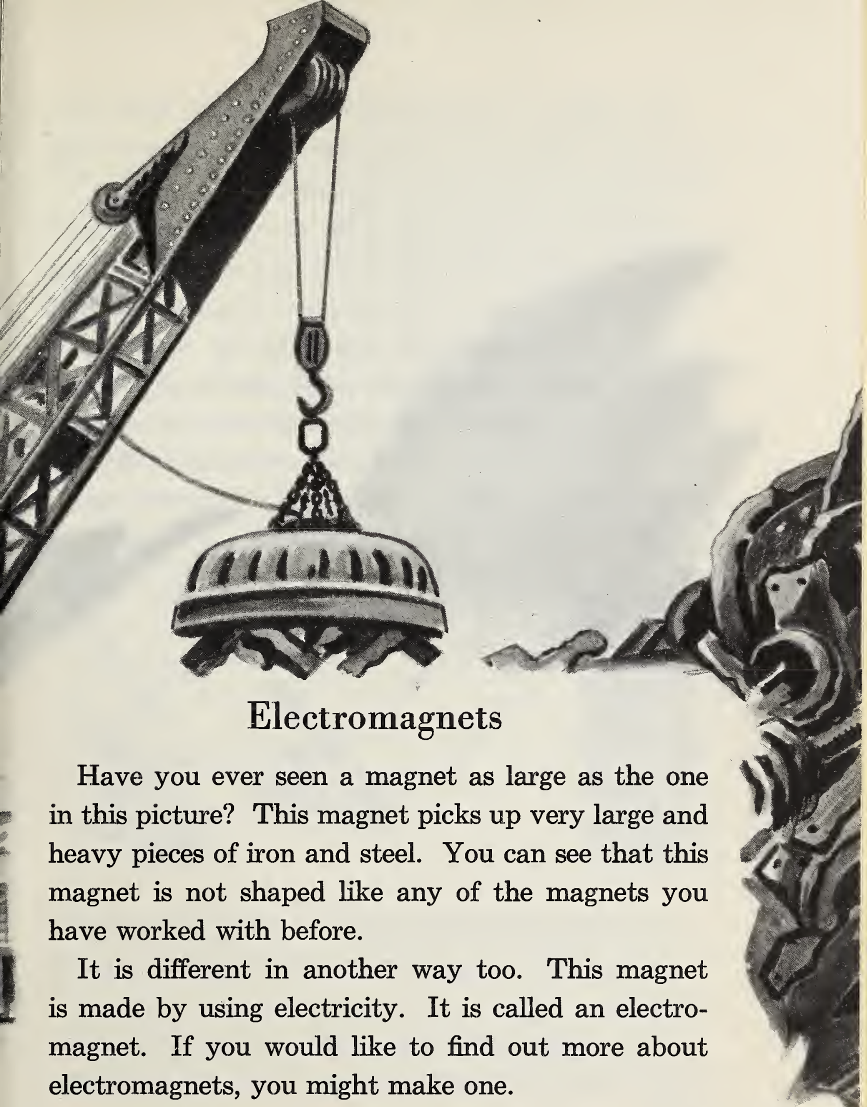
No one is sure whether this explanation of the earth's magnetism is true. But we can be sure of these things: The earth is a very large magnet. It is so strong that its magnetic field reaches over the whole earth. The earth has two magnetic poles. Compasses point toward the earth's magnetic poles.

SOMETHING FOR YOU

1. What do you suppose would happen to the poles of a magnet if you broke it into two parts? Would there be only a north pole on one piece and only a south pole on the other? Or would each piece have both a north and a south pole? Some small, toy horseshoe magnets are easily broken. Experiment with one of these.

2. Remember that the north pole of a compass needle is only *called* a north pole. It really is a south pole. That is why it points to the north magnetic pole.

About Electricity



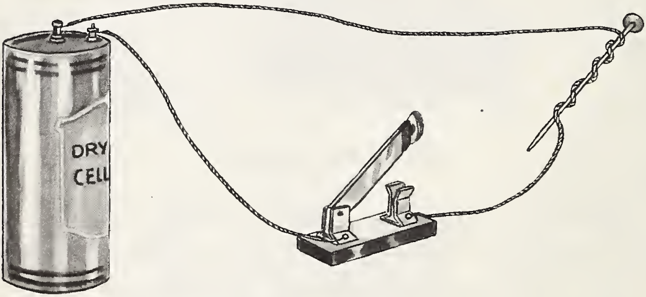
Electromagnets

Have you ever seen a magnet as large as the one in this picture? This magnet picks up very large and heavy pieces of iron and steel. You can see that this magnet is not shaped like any of the magnets you have worked with before.

It is different in another way too. This magnet is made by using electricity. It is called an electromagnet. If you would like to find out more about electromagnets, you might make one.

To make an electromagnet, you will need these things: a dry cell, a large nail, a switch, and about three feet of insulated copper bell wire.

Wind the central part of the wire smoothly around the nail. Fasten the end of the wire nearest the head of the nail to the middle screw of the dry cell. Cut a piece about six inches long from the other end of your wire so that you can put a switch in your circuit. The switch should go between the dry cell and the nail. You may use a knife switch like the one in the picture below, or you could use a push-button switch.



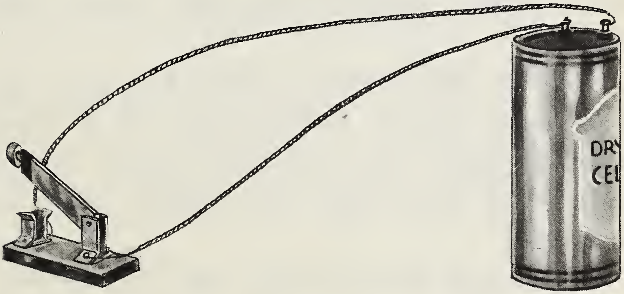
Put some tacks near the nail. Will the nail pick up the tacks? No, of course not. The nail is not a magnet.

Now press down the switch so that electricity flows through the copper wire. Now try to pick up the tacks with the nail. Do they jump toward the nail? You have made an electromagnet!

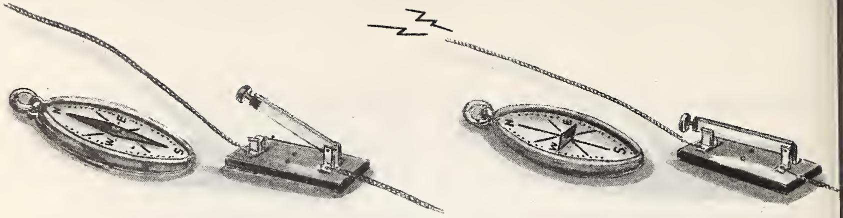
What happens when you turn off the current? The nail may have a little magnetism left. It may even hold one or two tacks. Why is the nail no longer a good magnet?

Scientists believe that the electricity flowing through the wire causes the molecules in the iron nail to line up in one direction. And then the nail becomes a magnet.

If you would like a nail to keep its magnetism for a long time, leave the electricity on for a while.



Perhaps you are wondering if the wire which carries the electricity is itself a magnet. You can test a wire through which electricity is flowing to see if it is magnetic. For this experiment, make a circuit like the one above.



Place a compass under the wire so that the two ends of the needle point in the same directions as the wire is lying. No electricity can go through the compass, because it is not connected in the circuit.

Now watch the compass needle as you press down the switch. Did you see the needle move? You know that an ordinary magnet will make the compass needle move. The electric current certainly acts like a magnet because it makes the compass needle move.

This fact, that an electric current flowing in a wire acts like a magnet, was discovered by a Danish scientist named Hans Christian Oersted. His discovery was made about one hundred twenty-five years ago.

Oersted told other scientists about his discovery. They used this new fact in many experiments. Finally they made the first electromagnet.

We now use electromagnets in many, many different ways. Huge electromagnets are used to lift great pieces of iron or steel. Perhaps you have seen one of these electromagnets at work.

Electromagnets are an important part of many of the things you use every day. Many doorbells have an electromagnet in them. The sounding key of a telegraph contains an electromagnet. Your telephone receiver has an electromagnet in it.

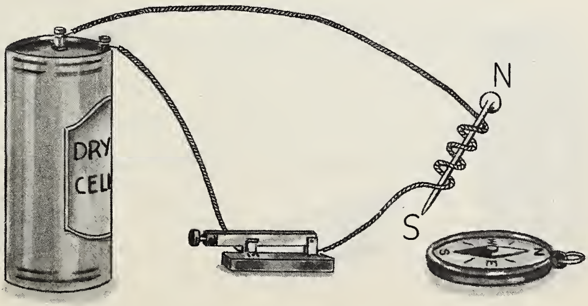
All our uses of the electromagnet go back to Oersted's discovery of electromagnetism. And this happened only a little more than a hundred years ago!

Poles of an Electromagnet

You know that an electromagnet picks up iron objects, just as other magnets pick up iron objects. Do you suppose that an electromagnet has two different poles, just as other magnets have?

You can test your magnet to see if it does have poles. Bring a compass near your electromagnet. In the picture below, the north pole of the compass needle is attracted to the pointed end of the nail.

Do you remember that north magnetic poles attract south magnetic poles? Now you should know

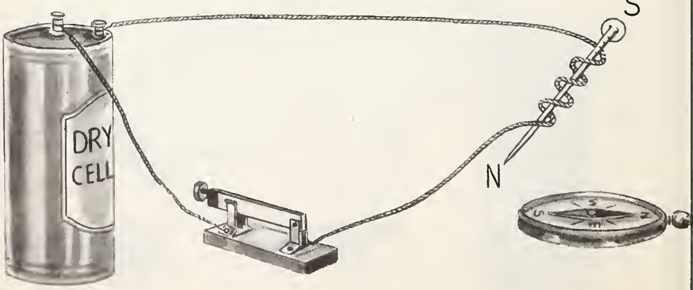


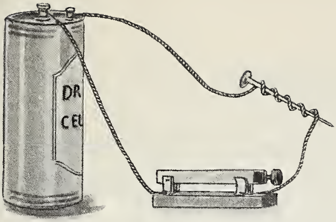
which pole the pointed end of the nail is. Yes, it is a south pole.

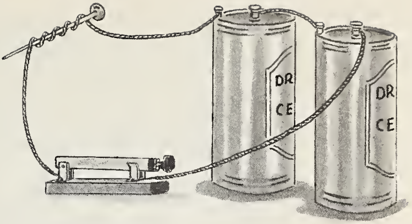
Move the compass to the other end of the nail. Is the south pole of the compass attracted to the head of the nail? Now you know that if a nail is wound with wire in the same way as the nail of your experiment, the head of the nail is the north pole and its pointed end is the south pole. Your electromagnet has two poles.

Disconnect the wires from the dry cell. Change the connections so that the wire which was connected to the middle screw of the dry cell is now connected to the outside screw.

Test the electromagnet to find which is the north pole and which is the south pole now. If your connections are made like the ones in this picture, the pointed end of the nail is now the north pole. We know this is true because the south pole of the compass needle is attracted to the pointed end of the nail. Only north and south magnetic poles attract each other.







When you changed the connections at the dry cell, you changed the poles of the electromagnet. We can always change the poles of an electromagnet by making the electricity flow first one way and then the other.

Strong and Weak Electromagnets

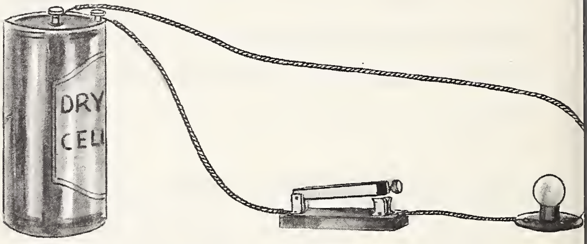
Could you guess which of the electromagnets shown above would be stronger? Why? If you guessed the circuit with two dry cells, you were right.

The strength of an electromagnet can be changed by changing the current. If the electric current is made stronger, the electromagnet will be stronger. Put another dry cell in your circuit. Will your electromagnet pick up more tacks than it did before?

You can make an electromagnet stronger in another way. Make an electromagnet with ten turns of wire on the nail. Count the number of tacks the magnet will pick up. Now wind more wire around the nail. Does it pick up more tacks?

Electric Lights

Have you ever thought about why light bulbs give off light? Of course they give off light only when they are a part of an electric circuit. When a light bulb is not screwed into a socket, it does not give off light. It is electricity that causes the bulb to give off light.



If you can get a flashlight bulb and a small socket for the bulb from a store in your neighborhood, perhaps you can make the circuit shown above. You will have to use a small bulb, since a dry cell does not furnish enough power to make a large bulb burn.

When you press the key of your switch, the light should glow. When you pull up the key of the switch, an air space is made through which the electric current cannot flow. The bulb does not glow.

The electric circuit is completed when you push the switch key down. If you are using a push-button switch, the circuit is completed when you press on the button. Electricity flows through the circuit. The small bulb gives off light.

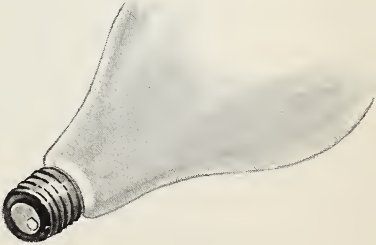
If your experiment does not work as it should, the circuit is probably not complete. It would be best to go over each part of the circuit to see that it is in order.

Did you make all the connections tight? Test each screw to make sure that no wire is loose. If all connections are tight and the bulb still does not glow, something is probably wrong with the dry cell or the bulb. The dry cell may be worn out, or the bulb may be broken.

The Light Bulb

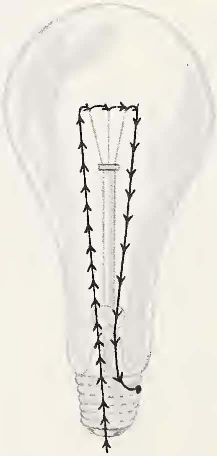
We have said that electricity leaves the dry cell and goes through the circuit. Have you wondered just how the electricity gets through the light bulb itself? Do you know where electricity enters the light bulb? Do you know where it leaves the light bulb?

Unscrew the light bulb from the socket. Look at the bottom of the bulb. Does the bottom of the light bulb look like this?



Electricity enters the bulb through the metal plate at the very bottom of the bulb. Then the electricity goes up through the wire in the center of the bulb and down to the brass ring around the outside of the bulb.

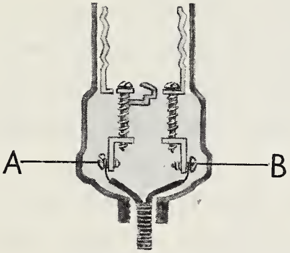
The arrows in this drawing of a light bulb show how electricity travels through the bulb. Compare this drawing with your light bulb.



The light bulb screws into a socket. There is a small piece of metal in the bottom of the socket. Electricity enters this part of the socket. Then it goes into the bottom of the light bulb.

Electricity travels up through the wires in the bulb and out the side of the bulb to the metal side section of the socket.

Look at your socket carefully. If you cut through it, would it look like this? Do you see where the electricity enters and leaves the socket?



Never put your finger in a socket. Your finger would make the connection between the small piece of metal at the bottom of the socket and the metal ring around the inside of the socket.

If you did this, you would become a part of the electric circuit of your house. The electricity in your house is much more powerful than the electricity furnished by a dry cell. If your body should become a part of this powerful electric circuit, you would get a bad shock.

Inside a Dry Cell

Have you ever opened a dry cell to see what it is like inside? Should you like to do that?

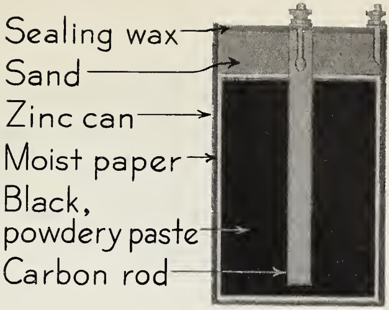
Spread a newspaper on a table and put your dry cell on the paper. You will not be able to put the dry cell back together again; so it might be best to use a dry cell that is almost worn out.

You will need a hammer and chisel or some such tools with which to open the dry cell. You might like to put an apron on so that you will not get your clothes dirty.

First take the paper cover off the dry cell. This paper cover is probably of little value except to make the dry cell more attractive. It also carries the name of the company that made the dry cell.

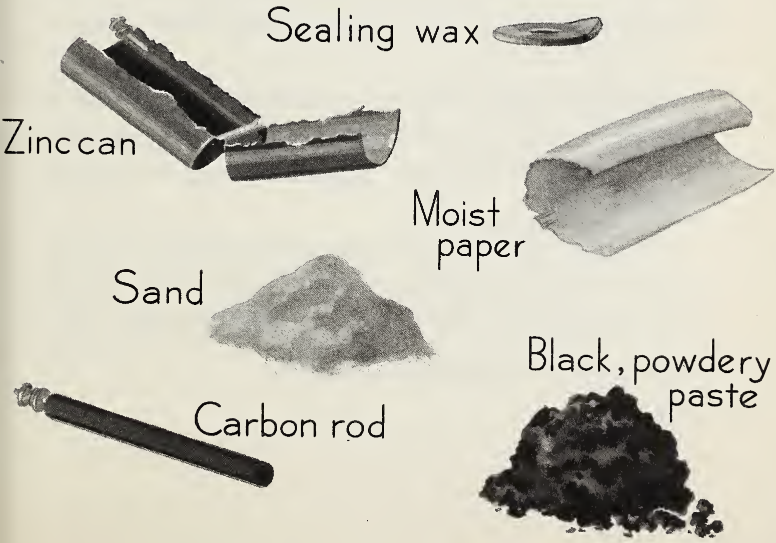
Now comes the real work. Split the metal can down the side. This metal can is made of zinc. Do you notice that the outside connecting screw of the dry cell is fastened to the zinc can?

Next comes some moist blotting paper, and then a black, powdery paste. Then you will find a black carbon rod in the center of the dry cell. The other



connecting screw of the dry cell is fastened to this central carbon rod.

On this page there are two dry cells. The dry cell above has been split so that you can see how the parts are put together. The dry cell below has been taken apart. Each of the parts has been labeled. Did you find the same parts in your dry cell?



Wax, sawdust, and sand were used to seal the dry cell at the top. This sealing is very necessary. A dry cell will not furnish electricity if it becomes really dry. It is called a dry cell because it is more dry than some other cells which furnish electricity.

The black, powdery substance around the carbon rod is a mixture of chemicals. These chemicals touch the carbon rod and the zinc can. Electricity is set free during the chemical reaction which takes place between all these things. When the dry cell is put in a complete circuit, the chemicals begin to act on one another.

Isn't it strange to think that it is really chemicals in the dry cell which are making your light bulb glow? Of course the chemicals did not go into the light bulb, but they did make electricity. Then the electricity went into the bulb and made it glow.

Now you know two very important ways in which electricity works for you. Electricity may be used to make electromagnets. Electricity may be used to give you light.

You also know something else about electricity. You know one way in which electricity may be set free. Electricity may be set free when certain chemicals are put together in a dry cell.

1. The storage battery in your car furnishes the electricity for the starter and the lights. Ask your father or your teacher to take you to a garage. The garage man will show you some of these batteries. Storage batteries are like dry cells in one way. They use chemicals to produce electricity for our use.

2. If you can get an old telephone receiver, take it apart and find the electromagnet.

3. Telegraphs use electromagnets. Find the directions for building a telegraph set and build one.

4. If you can find a large burned-out light bulb, bring it to school. Ask your teacher to help you break it. When you do this, you must be very careful not to cut yourself with the glass.

Wrap the light bulb completely in newspaper. Tap it with a hammer until it breaks. Unwrap the bulb. Are you able to trace the path of electricity through the bulb? Is this bulb like a small flashlight bulb?

5. Do you suppose dry cells furnish all the electricity for the lights in your school? No, of course not. Try to find out where this electricity comes from.

Knowing Plants

Large Plants and Small

Have you ever thought about how many living things there are around you? There are too many to count. You might easily count the birds, dogs, cats, trees, and bushes. But think of all the smaller plants!

Wouldn't it be hard to count all the grass plants growing on your lawn? Wouldn't it be hard to count all the moss plants growing in a damp place near your home?

Some plants are so small that you have never seen them. Some are a little larger. Some plants are very large.

Plants I Know			
Trees	Garden Flowers	Vegetables	Grasses
Maple	Rose	Turnip	Bermuda
Oak	Narcissus	Peas	Timothy

Sequoia trees are very large plants. These huge trees are found in California. Sequoia trees are among the largest plants ever known in the history of the world.

These trees grow to be very, very old. Some sequoias which have been cut down are thought to have been over four thousand years old. Imagine a plant living for four thousand years!

Yes, there are many, many plants growing near you. Not only is this true, but there are many, many different *kinds* of plants.

Try to make a list of all the different kinds of plants that you know. Think of all the different kinds of trees you know. How many different kinds of garden flowers do you know? How many different kinds of grasses do you know? You might make a list something like the one at the bottom of this page.

Your list of plants will be very long. Even then you have named only a small number of all the different kinds of plants in the world. There are many more kinds of plants than any one person can ever know.

Plants Are Alike

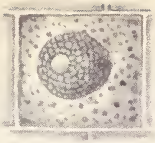
Plants may look very different from one another. An oak tree does not look very much like an onion plant. A rosebush does not look very much like a mushroom. Though these plants are not all green plants, they are all alike in one very important way.

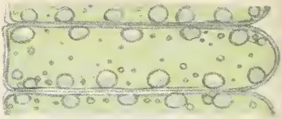
No matter what kind of plant you may think of, part of that plant is made of a substance called protoplasm. Protoplasm is a colorless material, somewhat like the white of a raw egg. It is not the material which gives a plant its color, since it has no color. But it *is* the living material of which all plants are made.

This material, protoplasm, is not exactly the same in all living things. It is slightly different in each kind of plant.

Perhaps you are wondering how plants have certain definite shapes and sizes if they are all made up of jelly-like protoplasm. This is because a tree or a rosebush or any other plant is not just a mass of protoplasm. The protoplasm is put together in very small parts called cells.

Cells are tiny packages of protoplasm with a certain size and shape. Every plant in the world is made up of one or more of these packages of protoplasm. Cells are put together to make a plant.


Cell from
onion root


Cell from
oak leaf

Plants Are Different

Pictures of cells from two plants which you know are shown above. An onion is made of thousands of tiny cells. An oak is made of thousands of tiny cells. The first picture shows the way one cell from the tip of an onion root would look under a microscope. The second picture shows the way a cell from an oak leaf would look if you saw it through a microscope. These cells look different from each other, but each one is a tiny package of protoplasm.

There are many plants which are so tiny that they are made up of only one cell. These plants are so small that a microscope must be used to see them.

Two different plants are shown in the picture below. Neither of the plants has roots or stems or leaves. Each of these plants is made of a single cell. Each plant is so tiny that you could never see it without a microscope.

Rod bacillus

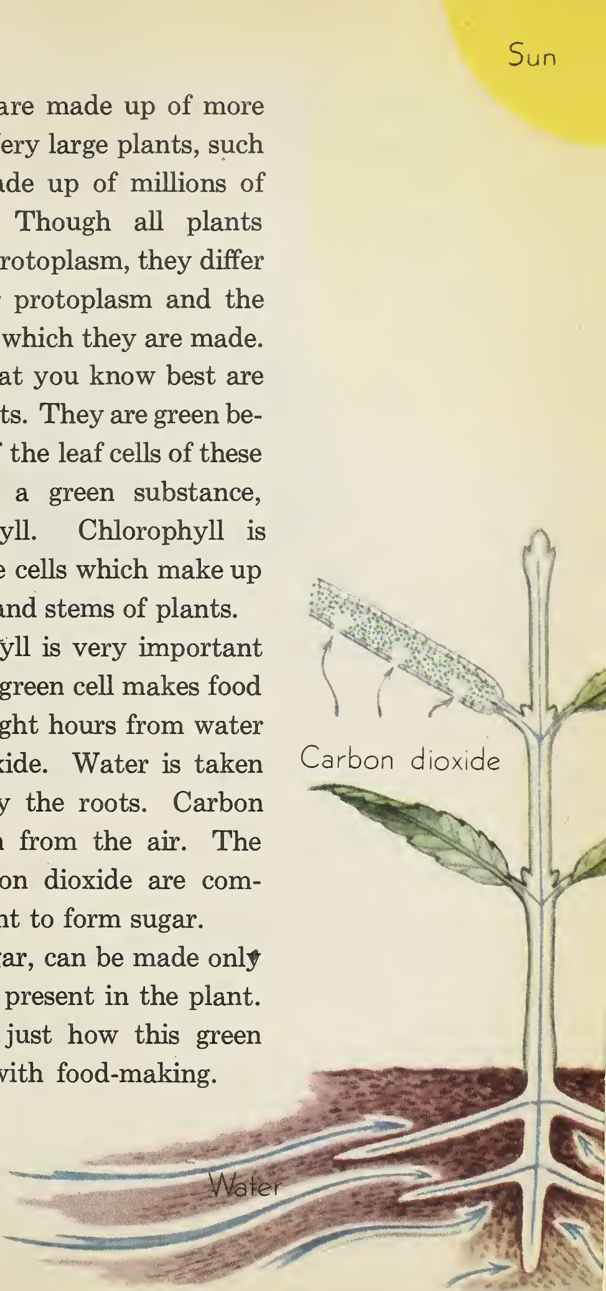
Round bacillus

Other plants are made up of more than one cell. Very large plants, such as trees, are made up of millions of separate cells. Though all plants are made up of protoplasm, they differ because of their protoplasm and the different cells of which they are made.

The plants that you know best are called green plants. They are green because in some of the leaf cells of these plants there is a green substance, called chlorophyll. Chlorophyll is also found in the cells which make up the green twigs and stems of plants.

This chlorophyll is very important to the plant. A green cell makes food during the daylight hours from water and carbon dioxide. Water is taken from the soil by the roots. Carbon dioxide is taken from the air. The water and carbon dioxide are combined in the plant to form sugar.

This food, sugar, can be made only if chlorophyll is present in the plant. No one knows just how this green material helps with food-making.



We do know these facts about green plants: Without light and chlorophyll, other materials cannot be made into food by a plant. Only green plants are able to make food.

Some plants do not have chlorophyll in any of their cells. These plants, then, cannot make their own food. They must depend on other living things for their food.

Sometimes these plants which cannot make their own food get their food from other plant materials. Sometimes they get their food from animal materials.

It is easy to see that not all plants are alike. Some are made of one cell, and some are made of many cells. Some plants make their own food, and some plants do not make their own food.

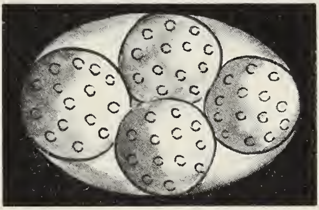
Yeasts and Molds

Would you ever guess that this package of yeast is made up of many, many living plants? Yet that is the exact truth. Each cake of yeast is made up of many hundreds of tiny living plants.

Each of these yeast plants is very, very small. It is so small that you would not be able to see it without a microscope.

Each yeast plant is made of only one cell. When we put hundreds of these one-celled plants together, we can see them.

Here is a picture of a yeast plant which is drawn many, many times larger than it really is. You would never be able to see this plant without a microscope.

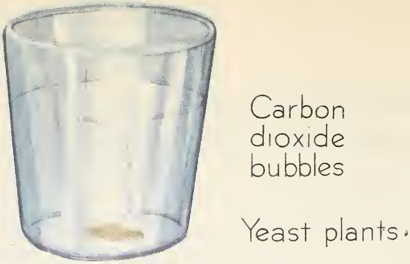


Think of a cake of yeast again. Do you think yeast plants make their own food? No, yeasts are not green plants. They have no chlorophyll. You would not expect them to make their food. Yeasts use food, but they do not make their own food.

Yeasts Use Food

You can see what happens when yeast plants use sugar for food. Put a little water in a small glass. Dissolve as much sugar as you can in the water.

Now open your package of yeast. Put a piece of yeast, about the size of the eraser on the end of a



pencil, in the glass. Put the glass of water, yeast, and sugar in a warm place.

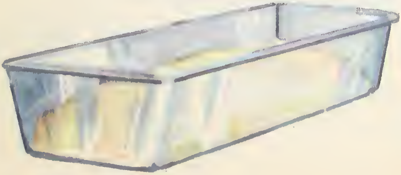
In a few minutes you will see bubbles of gas escaping from the liquid in the bottle. These are bubbles of the gas carbon dioxide. When the yeast plants use the sugar for food, carbon dioxide is given off.

Have you ever seen a loaf of freshly mixed bread just after it was put into a pan? If your mother does not make bread, perhaps you could take a trip to a bakery in your neighborhood.

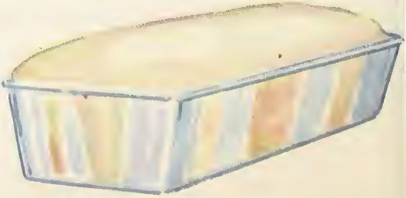
Freshly mixed bread does not nearly fill a pan. Before the bread is baked, it is put in a warm place for a while.

If you waited for a while and then looked at the loaf of bread just before the baker put it in the oven, you would notice that it had changed. The loaf of bread grew much larger, though no more dough was added to the pan.

Freshly mixed bread



Bread ready for baking



The reason the loaf grew larger, or rose, is this: Yeast had been mixed into the bread dough. The tiny one-celled yeast plants used the sugar in the dough for food.

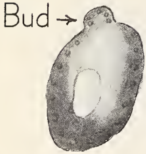
As they did this, a chemical change took place. Sugar in the dough was changed by the yeast plants. Carbon dioxide and alcohol were made. The carbon dioxide expanded. This pushed the dough up. The dough rose to nearly twice its size.

If now the dough is put in a hot oven, the heat causes the alcohol to evaporate. The carbon dioxide is also driven out. That is why bread is full of tiny holes.

Yeast plants, then, are used in making bread because they cause a chemical change as they use the sugar in the dough for food. If yeasts made their own food, this chemical change probably would not take place.

Yeasts Grow

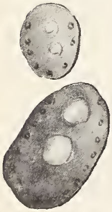
Even though each yeast plant is only one cell, it can grow. When yeast plants have plenty of food and are kept in a warm place, they grow very rapidly. If you could watch the growth of a yeast plant under a microscope, you would see some very interesting things.



First of all, the tiny yeast plant would grow a little larger. Then, when it reached its full size, a strange thing would take place. The one-celled plant would slowly begin to divide into two cells.

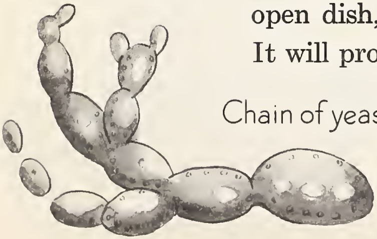
Where there was only one cell before, there would be two yeast cells now. Each of these cells would be very much like the other.

Suppose you had time to watch the yeast plants further. You would see that each of these two cells would grow to full size. If there were still enough food, moisture, and warmth, each of the two new cells would then grow and divide into two more cells.



In a few hours you would have four cells where there had been only one. As long as conditions were good, this would happen many times. After a while you would have thousands of yeast plants. They would be much like one another.

Yeast plants are all about us in the air. If you put some sweet fruit juice in an open dish, it will soon begin to change. It will probably turn sour.

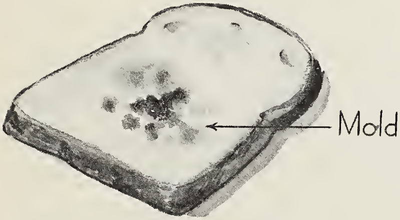


Chain of yeast plants

The fruit juice sours because yeasts which are in the air get into the fruit juice. They cannot make their own food. They use the sugar in the juice for food. There are many wild yeast plants in the air, but they are so very small that you cannot see them.

Molds Are Plants

Have you ever seen a piece of bread with black mold on it? Or perhaps you have seen an orange or a lemon with greenish mold growing on it.



Molds are plants which do not contain chlorophyll. This means, you know, that they cannot make their own food. That is why molds live on bread and other things. Since they cannot make their own food, they live on ready-made food. Perhaps if you look in your pantry at home, you may be able to find a piece of moldy bread.

If you would like to, you could grow some mold in your schoolroom. Take a piece of bread and put it in a dish. Keep the piece of bread slightly damp, and in a dark, warm place. In a few days you will notice mold growing on the bread. Where did this mold come from?

If you look at your bread through a magnifying glass, you will see tiny plants like the ones in the picture above.

Each mold plant is made up of many cells. Some of these cells form small, upright branches. On the end of some of these upright branches, little black, round knobs appear.

Within these little black knobs, certain very special cells, called spores, are formed. These spores grow and ripen. When the little black knobs burst open, the spores are so light that they are blown about in the air.

Air currents carry the mold spores about until they fall. Some spores fall into warm, moist places. If there is food too, the spores begin to grow.

Mold spores do not need sunlight, since they do not need light energy for making food. Mold spores grow into mold plants. These new plants produce more spores, which are carried about in the air. In this way, molds are spread about the earth.

If you have ever lived in a damp climate, you may have seen another kind of mold. Have you ever had mildew form on leather shoes or jackets? Mildew is another kind of mold. If you wish to keep mold from growing on leather, you should keep the leather dry. Molds need a moist, warm place in which to grow.

Mildew growing
on leather

Mushrooms and Puffballs

Have you ever seen mushrooms like the ones on the opposite page? You may call these plants toadstools.

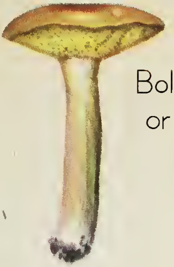
Sometimes mushrooms are white. Sometimes they are yellow or orange. There are even red mushrooms. But there are no green mushrooms. No matter what their color, they are all alike in one way. No mushroom can make its own food.

If you dig down into the ground from which the mushrooms are growing, you will usually find some rotting wood. The mushrooms use this dead plant material as food. They must do this because they have no chlorophyll.

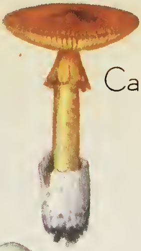
Spores are formed on the underside of the mushrooms. These spores drop to the ground when they are ripe. New mushrooms grow from these spores.

Some mushrooms are good to eat. Others are poisonous. You should never pick mushrooms and use them for food, because it is very hard to tell which ones are poisonous.

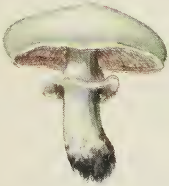
The white mushroom, the Destroying Angel, on the opposite page would poison you. The other white mushroom would not harm you. It is good to eat. Yet the two mushrooms look very much alike. The mushrooms you eat should always be bought in a store.



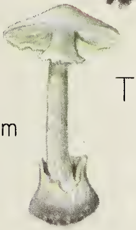
Boletus,
or cepe, mushroom
Edible



Caesar's mushroom
Edible



Field,
or horse, mushroom
Edible



The destroying angel
Deadly poisonous

The puffballs at the bottom of this page are like mushrooms. They grow in damp, shady spots where the soil is rich. These plants cannot make their own food either.

Tiny Green Plants

There are some tiny, one-celled plants which are quite different from yeasts. They are different from yeasts in two ways. First, they are green in color. Second, they can make their own food because they contain chlorophyll.

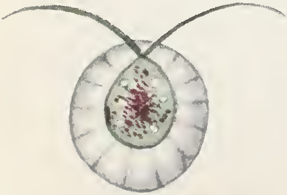
These green, one-celled plants are called algae. Some of the different kinds of one-celled algae are shown at the bottom of this page.

Sometimes you can find algae growing on trees in the woods. These one-celled plants often grow so near one another that they make a thin, green coating on a tree.

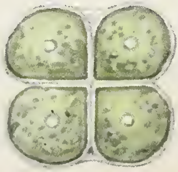
If you could take a small piece of the green coat and look at it through a microscope, you would see something like the second group of plants in the picture below. You would see that the thin, soft, green coating on the tree is made up of many one-celled plants.

Each tiny plant is almost round. Each of these tiny plants contains chlorophyll. This green material is always a part of any plant which makes food.

Sphaerella



Protococcus



Many of these tiny, one-celled plants may grow near one another. We say that they make up a group, or colony, of plants. Each green cell is a full-grown plant by itself. Each cell makes its own food. Each breathes. Each divides into more cells like itself.

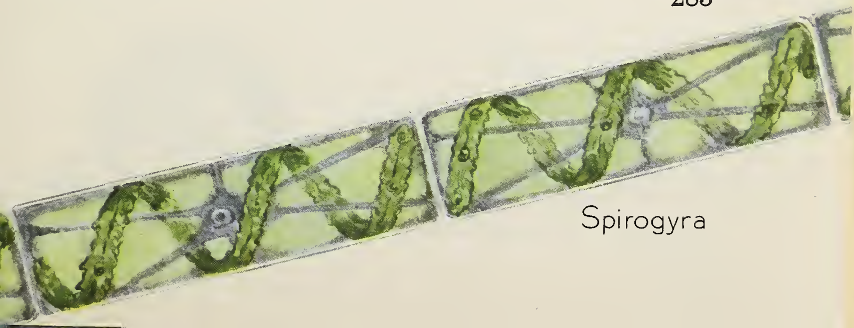
Other green algae look quite different from the kind of algae that grow on some trees. Have you ever noticed a green scum on some ponds?

You may call this "pond scum" or "frog spit." This green scum is made up of many, many green plants. If you could look at these plants through a microscope, they would look like the picture below.

The plants grow in thin, green strands. Each strand is covered on the outside with a thin layer of a substance which is much like gelatin. Each of these green strands is made up of a number of cells.

Each cell contains chlorophyll. Each cell is a separate plant. These green, one-celled plants make their own food from water and carbon dioxide.

We see, then, that even some very small plants are able to live and grow and make other plants like themselves.



Spirogyra

Ferns and More Ferns

Have you ever wondered why ferns do not have flowers? True ferns never have yellow blossoms or red or white blossoms. We say that ferns are not flowering plants.

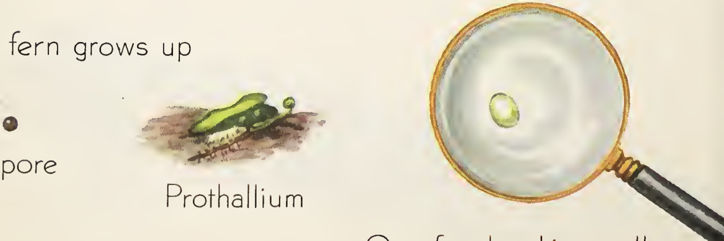
Since ferns do not have flowers, they do not have seeds. Ferns produce spores. If you look on the underside of some fern leaves, you will sometimes find a number of little brown spots.

On the underside of some of the fern leaves shown on the opposite page you will see these small brown spots. The brown spots are spore cases. There are many spores inside each of the spore cases.

When the spores are ripe, the spore cases break open. Then the spores are scattered. New fern plants grow from these spores. Not all the spores live. If they did, we should have millions and millions and millions of ferns.

At the bottom of these two pages are the stages in the life of a Boston fern. One spore grows until it becomes a large fern plant.

A fern grows up



Spore

Prothallium

One food-making cell

Ferns are green plants. They are made up of millions of tiny cells. The cells which contain chlorophyll are the food-making cells.

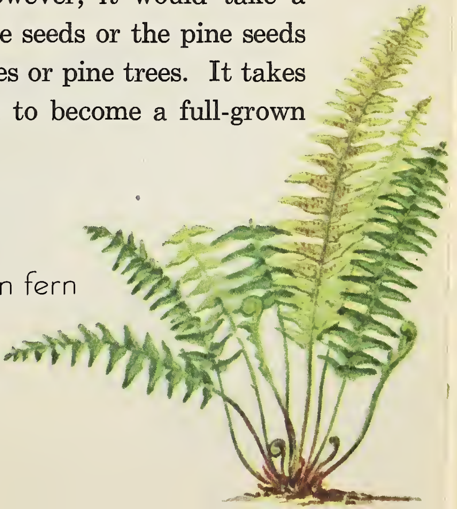
Have you ever thought about how many different kinds of ferns there are? See how many kinds you can find. Though there are many different kinds of ferns, they all grow from spores — not seeds.

Seed-making Plants

If you wanted to have a vegetable garden, you would buy vegetable seeds to plant in your garden. If you wanted a flower garden, you would buy flower seeds to plant in your garden. These seeds would become full-grown plants in a short time.

If you wanted maple trees, you could plant maple seeds. If you wanted pine trees, you could plant pine seeds. The seeds you planted would begin to grow before very long. However, it would take a long, long time for the maple seeds or the pine seeds to grow into large maple trees or pine trees. It takes a long, long time for a seed to become a full-grown tree.

Fern fronds

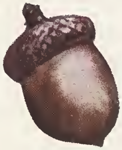


Adult Boston fern

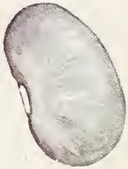
Many plants grow from seeds. There are hundreds of kinds of seed-making plants. Some seed-making plants, such as sequoia trees, are very, very large. Some, such as clover plants, are much smaller.

Some seeds are large; some are small. You might think that large seeds would grow into large plants and small seeds would grow into small plants. This is not always true.

Look at these seeds. The pictures show the real size of the seeds.



White-oak seed



Lima-bean seed

The first of the two seeds, though it is smaller, will grow into a very large plant. It will grow into a huge oak tree. The second seed will grow into a bean plant.

All seed-making plants are alike in this way: They are all green plants. That is, they all contain chlorophyll. You know that this means they can make their own food in the cells which contain chlorophyll.

Flowering Plants Are Useful

How many different kinds of flowering plants can you name? If you should begin to make a list of them, remember this: Many kinds of plants have such unusual flowers that you may never have thought of them as flowering plants.

Have you ever noticed the flowers of a maple tree or of wheat or of cabbage? Have you ever noticed flowers of corn or other grass flowers? Some of these flowers are very beautiful. You may not have noticed the flowers, either because they were small, or because their colors were not very bright.

Plants which produce flowers also produce seeds. There are so many different kinds of flowering plants that you cannot possibly know or name all of them.

Some flowering plants are grown only for their beauty. Others are grown because they furnish food for us. Try to name some of these plants.

Maple flower

Cabbage flower

Some flowering plants crowd out the useful plants in our gardens. We call these plants weeds. We pull weeds out to make more room for the flowering plants which we would rather have.

Still other flowering plants are poisonous to the human skin, as you know if you have ever had poison ivy. The pollen of certain plants causes some people to have hay fever.

Some flowering plants, such as apple trees or buckwheat, have flowers which produce nectar. Bees make honey from this nectar.

Many of our most useful medicines, such as quinine, morphine, and penicillin, come from plants.

Perhaps some of the most useful of all our flowering plants belong to the grass family. Corn belongs to the grass family. So do wheat, barley, rice, rye, timothy, and sugar cane.

Rice, a flowering plant, is the principal food of nearly half the people of the world. Corn and wheat

Corn flowers

Rice flowers

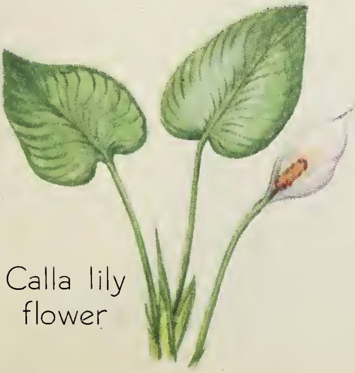
are used as food by man and by domesticated animals which man raises. Sugar cane, which is somewhat like corn, furnishes a great deal of the world's sugar.

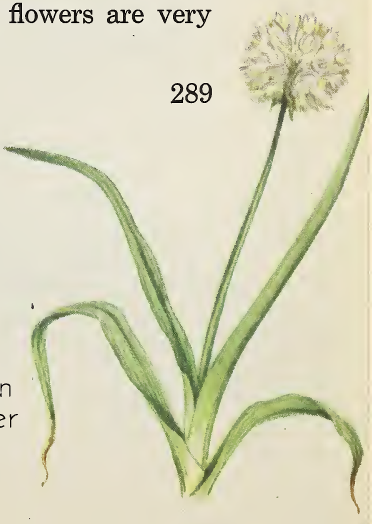
Groups of Flowering Plants

Scientists who are interested in flowering plants often group certain plants together for study. They do not put plants in groups because they are all tall or all short or because they all have red flowers or all have white flowers.

Plants may be put in certain groups because their flowers are much alike, or because their stems and leaves are much alike. Sometimes these plants may not look alike to us, but we may be sure that they are much like one another. Scientists can see ways in which plants are alike.

The plants below belong to the same family because their leaves are alike. Their flowers are very different.





Onions and calla lilies belong to the lily family. To this family also belong such plants as tulips, hyacinths, Easter lilies, tiger lilies, and narcissuses.

Many food plants belong to the lily family. Two of them, besides the onion, are garlic and asparagus. The onion and asparagus look very different from the tulip and hyacinth. But these plants all belong to the same group.

Roses belong to another large group of plants. They are in the same family with apple trees, raspberries, blackberries, and hawthorns.

These different plants may not look much alike to you. Their flowers may look quite different. However, the scientist who studies these plants knows that their flowers are really very much alike.

You will not find all the plants in any one group always growing near one another in the same part of the world. Think of some reasons why not all flowering plants grow well in the same place on the earth. Yes, the climate may be too cold or it may be too

Blackberry blossoms

warm for a certain kind of plant. Or a climate may be too wet or too dry for a certain plant.

Some flowering plants grow best in one part of the world, such as the tropical regions. Other flowering plants grow best in another part of the world, such as the temperate regions. These plants may be sent from one region to another to be used by man.

Flowers and Seeds

Every living thing, even a plant, has ancestors. These ancestors also had ancestors. And so the line goes far back in the history of the earth.

All living things come from living things. Living things cannot come from things which are not alive. Many years ago people believed that some living things came from decaying animals. Today we know that this is not true.

Flowering plants come from other flowering plants like themselves. Should you like to understand more about how this happens?

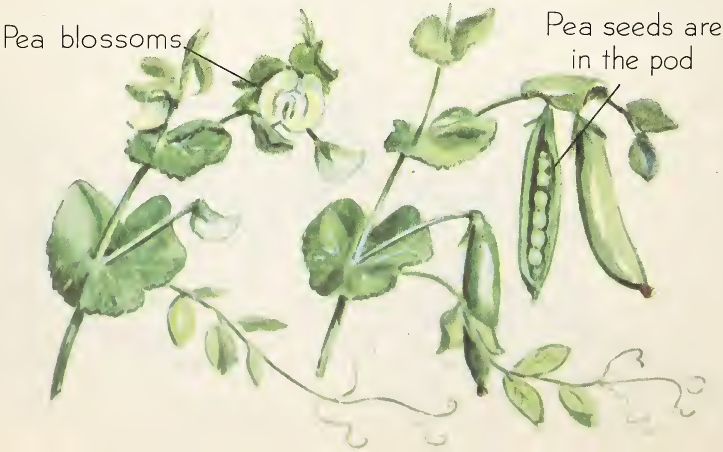
Apple blossoms

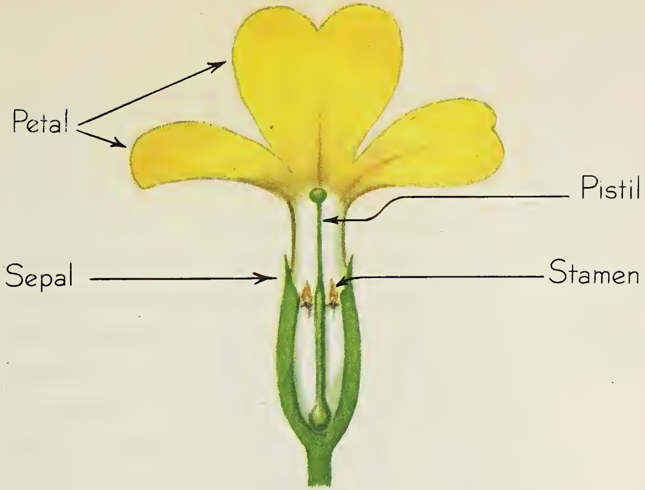
Flowering plants usually bloom in the spring and summer. After the petals drop off, we often find seeds in the place where the flower was. Have you ever noticed this about dandelion blossoms or pea blossoms or zinnia blossoms or other flowers?

In the case of some plants, fruit forms where the blossom appeared in the spring. Cherry blossoms fall to the ground. The white petals look like snow. Later you pick ripe cherries from the tree. The cherries have grown in the places where the blossoms were.

Apple trees, peach trees, and many other fruit trees blossom and bear fruit in this way. Almost always you will find seeds in the fruit.

These pictures show that pea pods are formed in exactly the same places on the vine where the flowers were. If you have a garden, watch for this to happen to the flowering plants.


Pea blossoms
Pea seeds are in the pod



Perhaps you would like to examine a flower to see where and how the seeds are formed. If you would like to do this, select a large flower like the primrose that you see above. If you select a large flower, you will be able to see the seed-making parts more easily.

This primrose blossom is set in a green cup of leaflike parts. These are the sepals. They cover and protect the blossom before it unfolds.

Then come the beautiful, colored petals. Some flowers have many petals. Some have only a few.

Now look inside the flower. What do you see there? If you have a blossom like the primrose, you will see several interesting parts inside the cup of your flower.

Primrose stamen

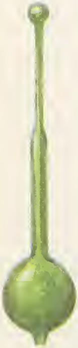
In the center you will find one or more pistils. These may be greenish-white or brownish in color. Around the pistil you will see several stamens. These are usually yellowish in color. The stamen and pistil are very important in seed-making.

If you have a magnifying glass, look at the stamen through it. Has it a knob at the end? In this knob, called the anther, are many little grains of pollen. In the pollen grains are the sperm cells, which you will read about later.

Pollen grains look like yellow dust. You might think that all pollen looks alike, but it doesn't. Rose pollen is different from apple pollen. Ragweed pollen looks different from zinnia pollen.

Now examine a pistil very carefully. You may have to pull out a pistil to see it well. Do you notice that the pistil has rather a thick base?

In this thickened part of the pistil are special cells called egg cells. Seeds will be made in this part of the flower. If the pistil of your flower is large enough, you may be able to split it lengthwise.



Primrose pistil

Some plants do not have flowers with stamens and pistils in the same flower. Sometimes the stamens are in one flower, and the pistils are in another flower. Pussy willows are like this.

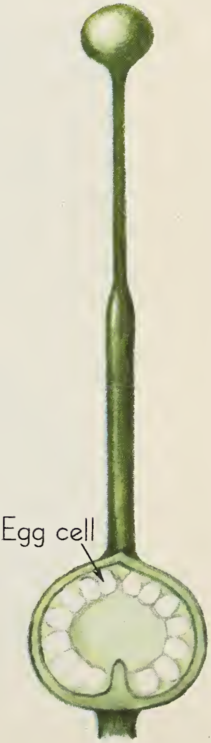
Primrose pollen grains

In flowering plants the wind or some type of insect carries the pollen from a stamen to a pistil. When a pollen grain falls on a pistil, the pollen grain grows.

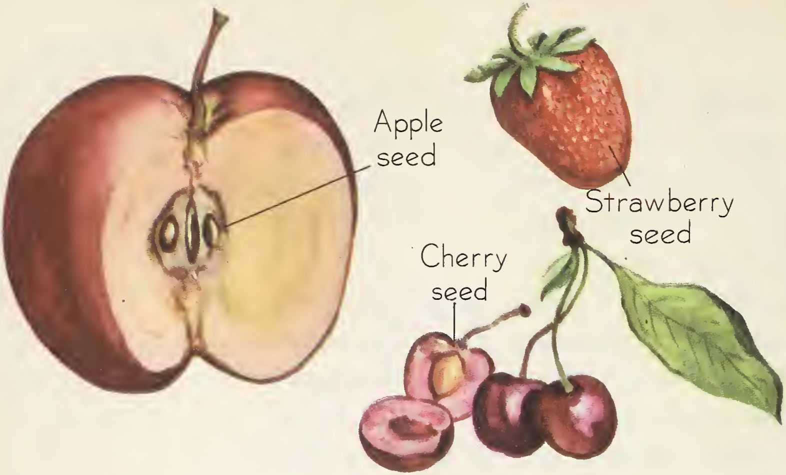
The pollen grain first grows a long, thin tube down through the pistil to the thick part at its base. When the tube reaches the base of the pistil, the sperm cell in the pollen grain unites with, or joins, one of the egg cells. This joining of a sperm cell and an egg cell is called fertilization.

After the egg cell has been fertilized, it begins to divide. First the egg cell becomes two cells. Then these two cells divide to make four cells, and so on. These cells grow and grow until a tiny plant is formed.

This tiny plant has food stored around it. The tiny plant, together with the food stored around it, is called a seed.



Egg cells in a primrose pistil



Sometimes the seed is well protected by a fruit. Aren't cherry seeds, pear seeds, apricot seeds, and grape seeds well protected?

If sperm cells from the stamens do not get to the egg cells in the pistil, no seeds are formed. This may happen when the wind or some insect does not carry pollen to the pistil.

After the seeds are ripe, they may fall to the ground. Or the seeds may be blown about by the wind or carried about by birds or other animals. Do you suppose that all the seeds formed by flowering plants each year grow up into new plants?

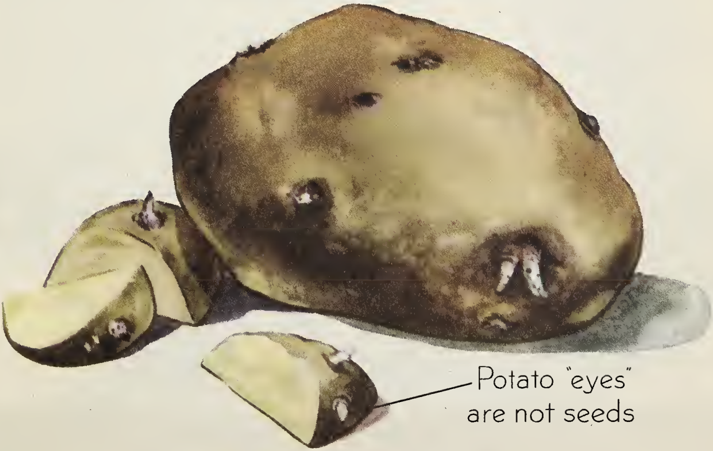
Imagine what the world would be like if every single seed which is formed each summer should become a full-grown plant!

A great many plants produce seeds which are so delicate that they do not often live to be full-grown plants. Roses do not produce very hardy seeds. Strawberries would be very hard to grow from seeds. Tulips do not grow easily from tulip seeds.

Farmers do not plant potato seeds when they want to grow white potatoes. They just plant parts of the potato itself.

Perhaps you would like to grow a white potato plant in your classroom. If you would like to do this, select a white potato. It should have large "eyes," or buds. Cut the potato into pieces so that there are one or two "eyes" to each piece.

Plant the pieces in flowerpots so that they are about two inches below the surface of the soil. Water them often enough to keep the soil damp.



Potato "eyes" are not seeds

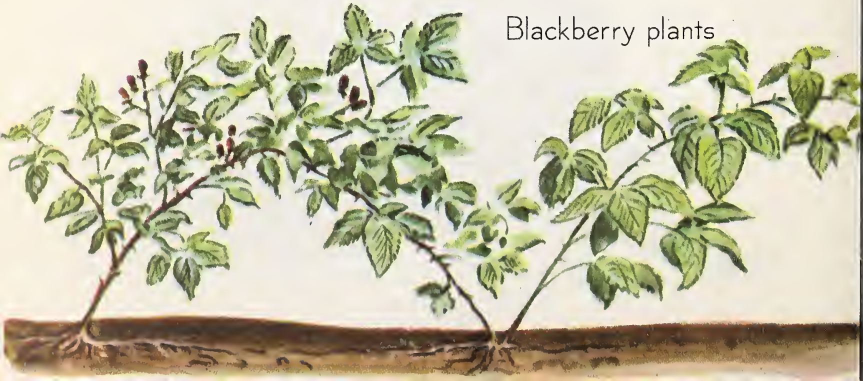
In a week or ten days the young potato plants will come through the soil. Keep the plants in a warm, light place so that they will grow well.

After the plants have been growing for about two weeks, carefully take one of them out of a flowerpot. Can you find the piece of potato that you planted? What has happened to it?

There are many other plants which are usually not grown from seeds. If you wanted to grow new grapevines, you would cut pieces off an old grapevine. Then you would stick these pieces in the soil.

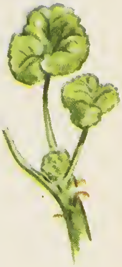
After a while new roots would begin to grow. These cuttings would grow into large grapevines in a few years. Of course you could grow grapevines from seeds, but it would take a long, long time.

Raspberry and blackberry bushes grow to be fairly tall. If you have a blackberry bush in your garden, you can grow new bushes easily. Turn the top of one of the tall branches down and cover it carefully with soil.



Blackberry plants

A new blackberry bush will grow from this buried tip of the old plant. After a while the old branch will die. Then you will have two entirely separate plants—the old one and the new one.



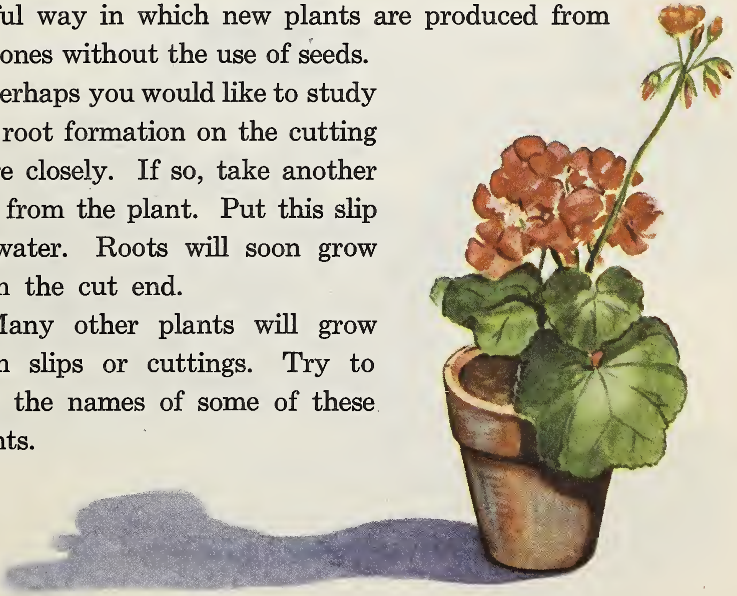
If you have a geranium or begonia plant in your classroom, you may try this experiment: Ask your teacher to show you how to cut a slip, or cutting, from the plant.

Now fill a flowerpot with rich, moist earth. Plant the slip in it. Be sure that the soil is packed firmly around the new plant.

Water the plant each day so that the soil will not become too dry. In a few days your plant will develop roots and begin to grow. This is a very useful way in which new plants are produced from old ones without the use of seeds.

Perhaps you would like to study the root formation on the cutting more closely. If so, take another slip from the plant. Put this slip in water. Roots will soon grow from the cut end.

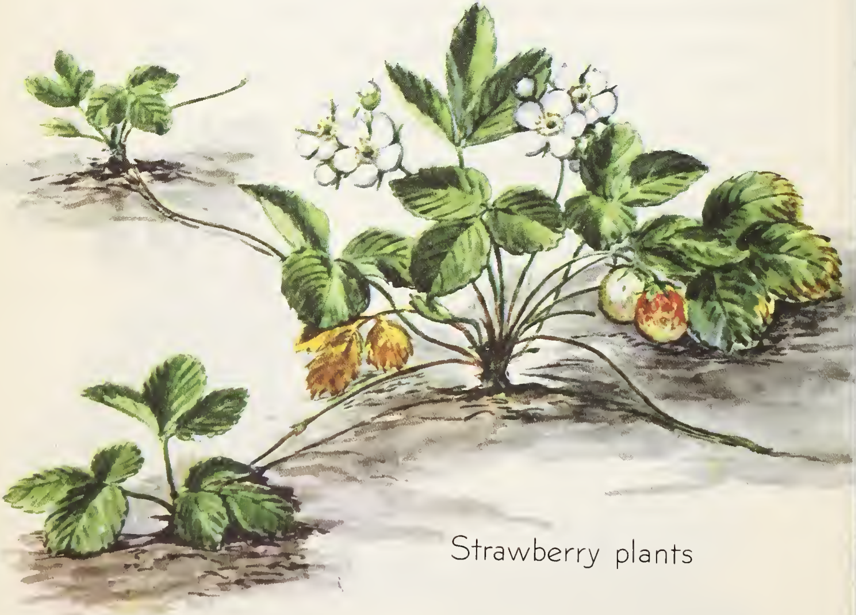
Many other plants will grow from slips or cuttings. Try to find the names of some of these plants.



New willow trees can grow from small branches of old ones. These small branches must be planted in moist soil. Privet hedges may be grown from slips, or cuttings, also.

Have you ever seen young strawberry plants growing? Strawberry plants are set out in rows or in hills. Soon each plant extends long runners in all directions.

On these runners are small leaves. Roots develop below these small leaves. If the soil is soft, the roots grow into the ground, and a new plant is started. Soon the runner dries up and dies. Now the new plant is entirely separate from the old plant.



Strawberry plants

While the new plant is very young, it receives some food from the old plant. When the new plant is able to make food for itself, it no longer needs food from the parent plant. The green leaves are now food-makers for the new plant.

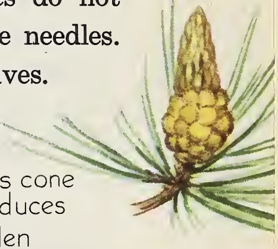
Flowering plants, then, may be grown from seeds. They may also be grown from bulbs or from cuttings or from runners.

Trees without Flowers

Some trees do not have flowers; yet they do produce seeds. Evergreen trees, such as pines, firs, hemlocks, and spruces, are in this group. These trees are called evergreen because there are always green leaves on them.

Perhaps you are saying that pine trees do not have leaves. You may say that they have needles. The needles of evergreen trees are really leaves.

Pine trees have cones instead of flowers. Pines have two kinds of cones. One kind of cone produces sperm cells, which are inside pollen grains. Pollen grains are blown by the wind to the kind of cone which produces egg cells.


This cone produces pollen

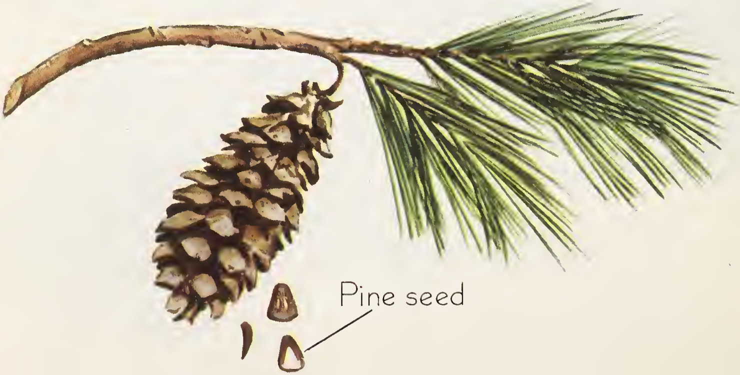
This cone produces egg cells

The cones which produce pollen are smaller than those which produce egg cells. When the sperm cells are fully grown, the pollen is scattered by the wind. The pollen looks like a yellowish powder. You know that this yellowish powder is made up of tiny, living sperm cells.

The wind carries the pollen about. Some of it may fall on the kind of cone which produces egg cells. When this happens, a long pollen tube grows down to an egg cell. A sperm cell then unites with the egg cell. Does this same kind of thing happen in flowering plants?

The fertilized egg cell develops into a pine seed. These pine seeds have very small and delicate wings. When they ripen, they are carried away by the wind. When these seeds fall to the ground, some of them may develop into new pine trees.

If the ground is warm and damp, the tiny plant within the seed may begin to grow larger. The cells in the young plant grow into more and more cells.



Some of the cells become the roots. Other cells become the stem. Still other cells become the leaves. Finally the roots are quite able to furnish the young pine with water and minerals from the soil. Then the leaves begin to make food for the new plant.

Pine seeds, as is true of other seeds, contain much food material for the young, growing plant.

SOMETHING FOR YOU

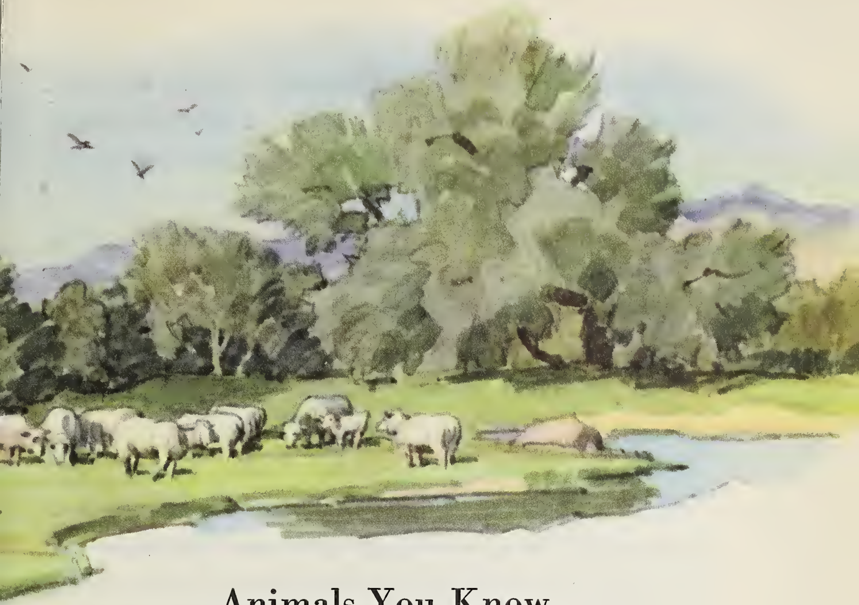
1. Here are some things to think about:

Think of the ways in which plants are alike.
Think of the ways in which plants are different.
Think of plants which grow from seeds.
Think of plants which do not grow from seeds.

2. Plant an indoor garden of beans and peas. Put your garden near a window so that it can get sunlight. Water it every day. Watch for the flowers. Do the bean pods and pea pods come in the same places where the flowers grew?

3. Take a walk through the woods and fields if you live in the country. Take a walk in the park if you live in the city. See how many different green plants you can find. See how many different plants you can find which are not green.

Knowing Animals



Animals You Know

How many animals do you see in this picture? Did you know that birds are animals? Turtles and frogs and sheep are animals, too.

Should you like to play a game? This game is called "Animals I Know."

Let two persons in your class choose sides. Your teacher will help you to keep score. Now let the first person on one side name an animal. Now the first person on the other side names an animal. Then let the second person on the first side name an animal, and so on. All the animals must be different!

Your game is quite like a spelling bee. If a person cannot think of a different animal, he must sit down. Find out which person is the champion animal-namer in your class.

If you were a scientist who studied animals, you would be able to stand up for a long time in your game. You would be able to name hundreds of different animals.

Not even scientists who study animals could name all the different animals in the world. There are thousands of different animals.

Some animals are huge. One kind of whale, which lives in the ocean, is larger than any elephant you have ever seen. Compare this picture of the world's largest whale with the picture of the world's largest elephant on the next page.

Other animals are so small that you cannot see them without a microscope. Most of the animals you see about you are "in-between" in size.

We usually think of dogs as being medium-sized animals. Yet there are many different sizes of dogs. Some full-grown dogs are small enough to fit easily into a shoe box. Other dogs are so large that they weigh more than you do.

You may have seen ponies that are about as tall as you are. On the other hand, some types of work horses weigh over a thousand pounds.

Animals are of many sizes and shapes. They are of many different colors. In one way all animals, like all plants, are alike. Protoplasm is found in all plants and animals. The protoplasm in animals is in cells, just as it is in plants.

It is true that there is protoplasm in both plants and animals, but plant protoplasm is different from animal protoplasm. Protoplasm is a little different in each kind of animal too. But all living things are made up of protoplasm.

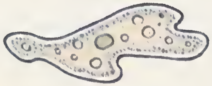
Animals are different from plants in this way too: Though there are green caterpillars and grasshoppers, animals do not have chlorophyll. You know what this means. Animals cannot make their own food. They cannot use carbon dioxide and water, with the help of light, to make food.

Animals must hunt for food. Many of them move around to do this. All animals eat other animals or plants to keep alive. If they do not eat, they die.

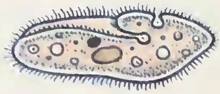
Animals without Bones

Would you ever guess that the pictures on these two pages are pictures of animals? These are only a few of the many different one-celled animals in the world. Like one-celled plants, these one-celled animals are found almost everywhere.

Some of these tiny animals live in ponds and streams. Others live in the salt water of the ocean.



Amoeba



Paramecium

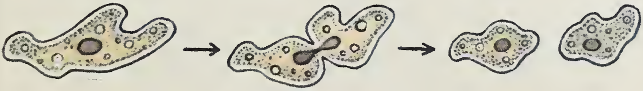
Some of these tiny, one-celled animals live in the soil. Others live in the blood of larger animals. Many kinds live in the sap of plants. Some of these animals cause diseases. Malaria and sleeping sickness are caused by one-celled animals that find their way into the blood of people.

Scientists have studied and named about fifteen thousand different kinds of one-celled animals. How many different kinds of these tiny animals there are!

If you named a different one-celled animal every second, it would take you almost two whole days to name all the different one-celled animals that we know about. Yet there are probably many more kinds that have not been discovered.

None of these tiny animals have bones. They do not have heads or legs or eyes, as we have. They are made of only one cell, but they are living, growing animals.

Do you remember that one-celled plants divide to make new cells? This is the way they produce other plants like themselves. One-celled animals do this, too. A one-celled animal may produce many, many other one-celled animals in one day.



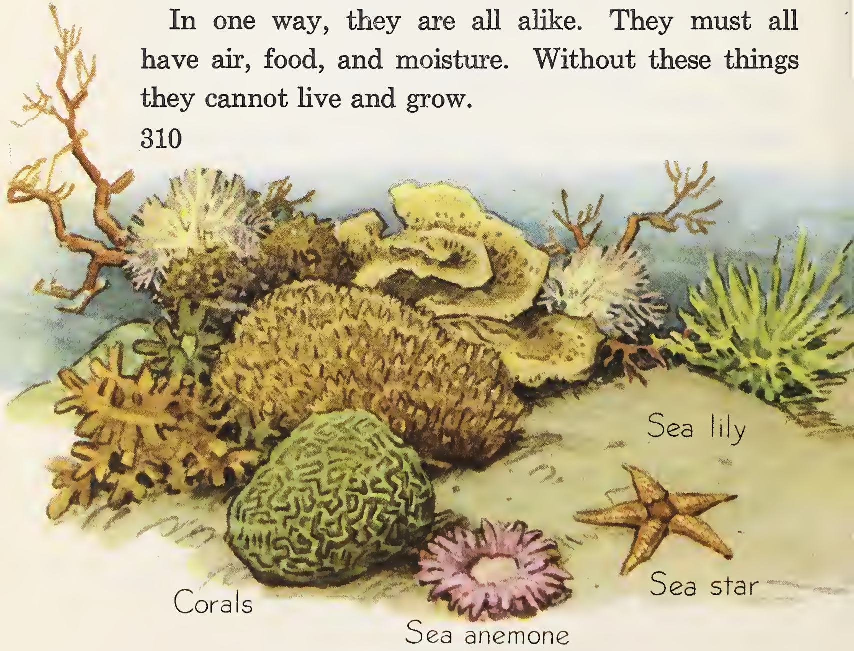
An amoeba divides

What a strange world this would be if no one-celled animals died for two weeks! Can you think of the many, many millions of one-celled animals there would be at the end of two weeks?

Many one-celled animals are very interesting. Some of these small animals eat other one-celled animals. Some of them do not like to be in bright sunlight. They move into the shade if sunlight falls on them.

Some will live only in clear water. Others like water in which there is much dead plant material. Some of them live near the surface of the water, and others live near the bottom.

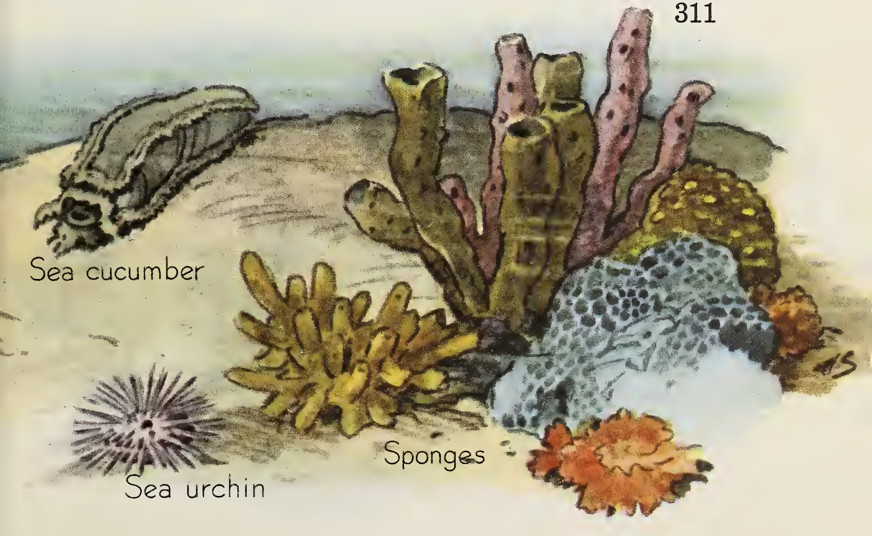
In one way, they are all alike. They must all have air, food, and moisture. Without these things they cannot live and grow.



Many of the animals without bones are found in the oceans and seas of the world. This picture shows the bottom of a tropical sea. All the living things in this picture are animals. None of them have bones in their bodies. Some of them are beautifully colored. They look somewhat like plants.

Sponges are many-celled animals which are found in warm seas, but which you probably will never see alive. The same is true of corals, which also live in the warm oceans.

On the floor of the warm seas and oceans are many queer kinds of animals. Some of these creatures look very much like plants. They never move from one spot. Their food is brought to them by ocean currents.

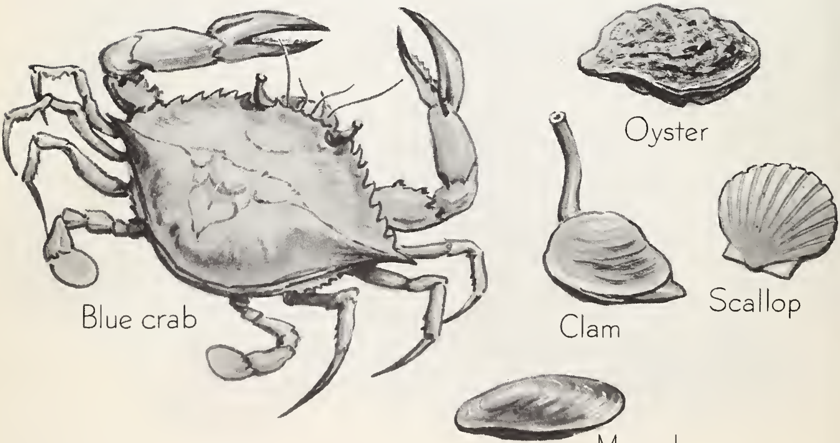


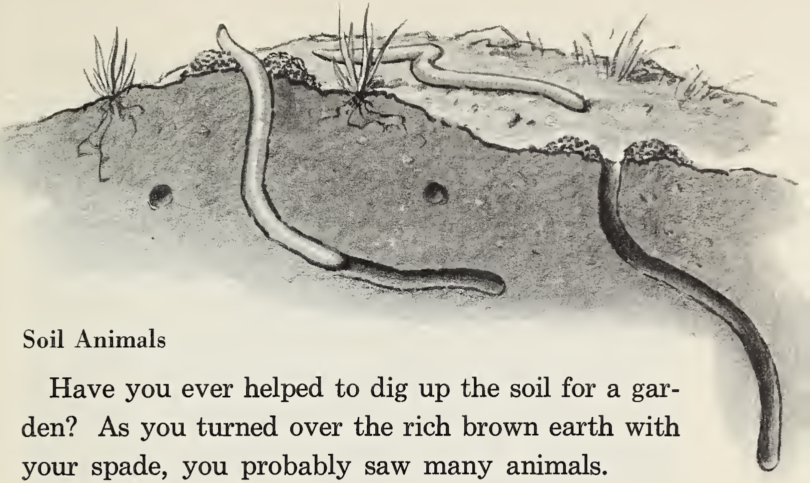
Some of these animals look so much like plants that they are even called sea cucumbers. Others of these strange sea animals are called sea lilies.

Starfish are found in great numbers in warmer water near the shores. These animals are not really fish. They have no bones within their bodies.

Perhaps you have seen other sea animals without bones; perhaps you have eaten some of them. Do you like to eat oysters or clams or mussels or crabs or scallops? None of these animals have bones in their bodies.

Oysters, clams, mussels, crabs, and scallops do have a hard outer covering. This hard outer covering is of great use to them. It protects these soft-bodied animals from their enemies. It is very hard for the enemies of oysters and clams to open their shells.





Soil Animals

Have you ever helped to dig up the soil for a garden? As you turned over the rich brown earth with your spade, you probably saw many animals.

Did you dig up any fat, white grubs? These were probably insects in the resting stage of their life. Did you find any small bugs which ran away to hide? Perhaps you found earthworms.

Earthworms are very common animals. If you have not seen them in a garden, you may have noticed them on your lawn after a rain.

As earthworms burrow through the soil, they make places for themselves to live. Usually their nests are lined with very small pieces of leaves.

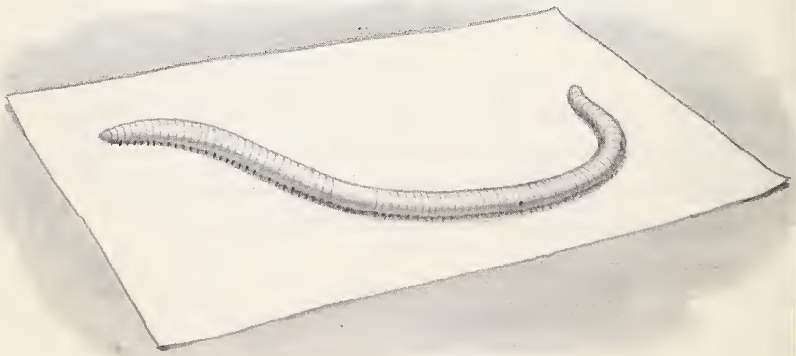
Their burrows open at the top of the ground so that air can enter the burrows. When it rains hard in the early spring and summer, the burrows become filled with water. The earthworms would drown if they did not crawl out of their burrows.

Perhaps you would like to look at an earthworm. Get a large one if you can. Sometimes they grow to be as long as ten inches. Notice that the body of an earthworm is made up of different sections.

Put your earthworm on a sheet of paper and watch it. Can you describe how it moves from one place to another? The small, hairlike things on the lower surface of its body help an earthworm to move about.

Notice that an earthworm has no bones. It has no legs, no head, no neck. But an earthworm does have a head end. You can find out which end is the head end by watching the earthworm. That end of its body always moves forward first.

If you would like to keep some earthworms in your room, put some rich soil in a large jar. Be sure that the soil is moist, but not wet. Put a few earthworms on the top of the soil. They will soon burrow down into the soil.



You will have to sprinkle some water on the top of the soil from day to day to keep it moist. If the skin of an earthworm gets too dry, the earthworm will die. There are small holes in the skin through which the earthworm breathes. If the skin is not moist, these holes do not open and close properly.

Never pour much water at a time on the top of your earthworm home. If you do, you may make the home too wet. The earthworms may drown.

Have you ever seen very small, thin earthworms? These may have been baby earthworms. Baby earthworms are smaller and lighter in color than older earthworms.

Earthworms lay eggs in the soil. Of course these eggs are small. The tiny, baby earthworms hatch from these eggs. Small earthworms must take care of themselves. Their mothers crawl away after they lay their eggs. They never see their babies.

Not all earthworms live to be full-grown. They have many enemies. You have probably seen robins hunting for earthworms. Moles eat earthworms, too.

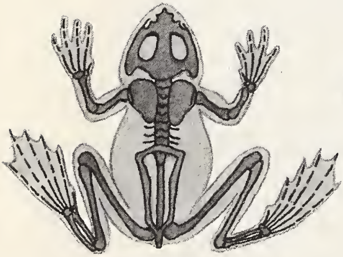
However, in spite of these enemies, some earthworms do live to be full-grown. This is a good thing because earthworms help to keep the soil soft by burrowing through it. Which do you think is better—to kill earthworms or to protect earthworms?

Animals with Skeletons

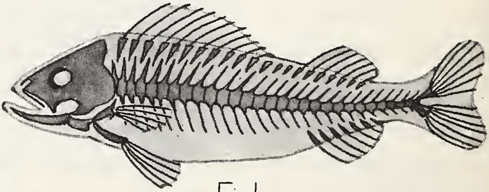
Here is a puzzle question. How are one-celled animals, corals, and earthworms different from dogs, snakes, and birds? Perhaps you say that no animal in the first group has legs and that all the animals in the second group have legs. That is right.

There is another difference too. No animal in the first group has bones inside its body. Each of the animals in the second group does have bones. Fish, snakes, turtles, frogs, birds, rabbits, and many other animals have a strong skeleton. This skeleton of bones supports them and makes their bodies stronger.

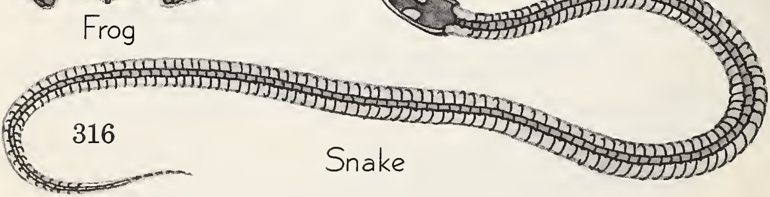
What would a bird's wings be like if they had no bones in them? What would happen to your legs if they had no bones?



Frog



Fish

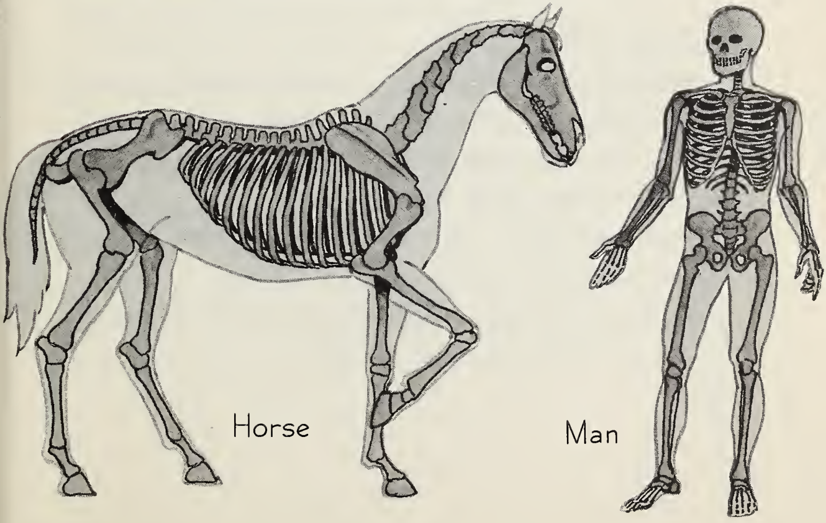


Snake

None of the one-celled animals have skeletons. Some of the many-celled animals do not have skeletons either; but many of them do. Most of our common animals do have skeletons.

We have skeletons. Feel the bones in your hand. Wiggle your fingers and watch these bones move. Feel the bones in your hand and wrist. How many there are!

Should you like to see the bones in your hand? Darken the room on a bright, sunny day. Put one shade up a little bit. Hold your hand before the opening. Does the light shine through enough for you to see the bones in your hand? Another way to see the skeleton of your hand is to hold your hand over the lighted end of a flashlight. Do you see the bones now?



Look at the skeletons of the man and the horse. Do they both have leg bones? Do they both have feet bones? Do they both have skulls? Imagine that the horse is standing on its hind legs. Would the two skeletons look somewhat alike?

The bony skeletons of the larger animals are very necessary to them. They would not be able to hold themselves up without bones.

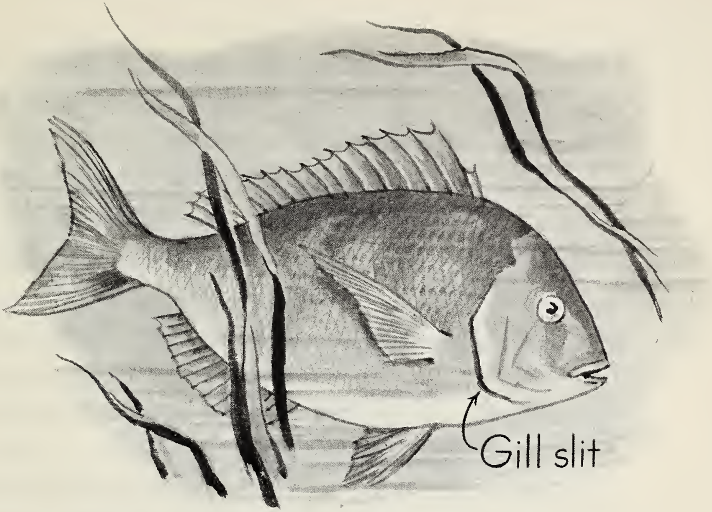
These skeletons are not dead things. They are made of living, growing bones. You are growing taller because the bones in your body are growing longer. This is the way many animals grow larger.

If your bones stop growing longer, then you will not grow taller. If a bone breaks, it must be allowed to mend. Until the broken bone is mended, you cannot move that part of your body easily.

Fish Are Water Animals

Have you ever thought of going fishing on dry land? What a silly question! Fish are water animals. They are born in water. They spend all their lives in water. Here they live and grow.

Fish need air to live, just as any other animal needs air to live. These water animals have very special body openings to get the air which they need. These openings are called gill slits.



Do you see the gill slit in this picture? All fish have gill slits just behind the head. There are two slits, one on either side of the body.

Perhaps you remember that there are air bubbles in fresh water. Fish take in water through their mouths. Then this water passes through a tube in their heads and out through the gill slits.

As the water passes through the body, air is taken from the water. Have you ever watched a goldfish open and close its mouth as it swims through the water? Now you know what it was doing. It was getting air.

Sometimes there is not enough air in the water in which goldfish are living. When this happens, the fish come to the top of the water to get air. If you see fish doing this, change the water in your bowl. Fresh water will have plenty of air for the fish.

Some fish are very hard to eat because they have so many little bones in their skeletons. You are always very careful not to get one of these bones in your throat. If you feed fish to your cat, you should take out all the bones first. Cats cannot do this for themselves.

Do you know what would happen to fish if they did not have bones? They might be pressed right together. The water presses on all sides of a fish. The skeleton of the fish helps to hold its body in the proper shape.

Fish are like other animals in another way too. They have blood. Fish are called cold-blooded animals. This does not really mean that their blood is cold all the time. However, sometimes their blood is colder than ours is.

The blood of all cold-blooded animals is usually about the same temperature as the water or air in which they live. If the water becomes colder, then the blood of a fish becomes colder. If the water becomes warmer, then the blood of a fish becomes warmer.

Most of the different kinds of fish lay eggs. These eggs are laid in the spring of the year. After the eggs hatch, the young fish find food for themselves. Only a few fish, one of which is the stickleback, build nests and take care of their young.

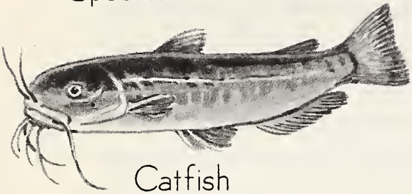
Some fish, such as guppies and other kinds of tropical fish, are born alive from the mother's body. These fish take care of themselves as soon as they are born.

Baby fish, as well as full-grown fish, eat many different kinds of food. Carp live in muddy streams and feed on food materials in the soft mud at the bottom. Some fish live on other fish which are smaller than themselves. Other fish live on insects. These fish are very useful to us. They eat many "wrigglers," or mosquito larvae. Keeping many fish in our ponds and streams helps to kill mosquitoes.

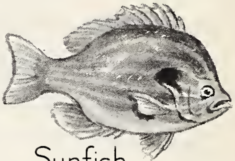
Carp

Speckled trout

White lake bass



Catfish



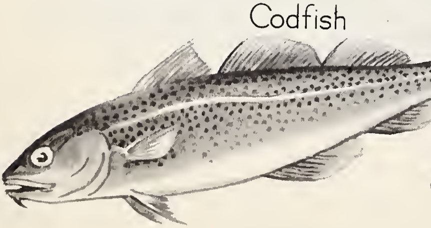
Sunfish

Here are some of our common North American fresh-water fish. Perhaps you have fished for speckled trout in swift mountain streams. You may have fished for sunfish and bass in a lake near your home. Do you know some ways in which all these fish are alike?

Catfish are different from most other fish in one way. Perhaps you know what it is. Catfish have no scales. They have a smooth skin.

Cod and mackerel are two of our most important ocean fish. Fishing boats go out into the ocean to catch these fish. These fish are like most of the fresh-water fish you know about. They have scales. They have skeletons. They are cold-blooded. They lay eggs. They feed on plant food or on smaller animals.

Codfish



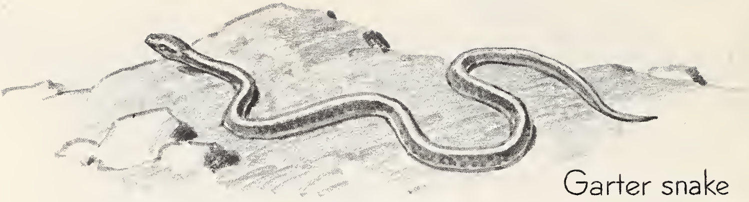
Mackerel

If you live on a farm, you have seen snakes many times. Perhaps you have seen snakes at summer camp. You may even have had a garter snake for a pet. Have you ever noticed that you do not often see snakes in the winter?

Snakes are winter sleepers. They hibernate during the colder months of the year. The reason for this is that they are cold-blooded animals. This means the body temperature of a snake may sometimes be warm and sometimes cool. A snake is as cool or as warm as the air or water around it. If snakes moved about on the top of the ground in the winter, they would become so cold that they might freeze and die.

Can you think of some ways in which snakes are like other animals? Snakes need food, air, and water to live. Another likeness is that they have a skeleton.

The backbone of a snake is about as long as its whole body. There are small bones coming out from either side of this backbone. They help to protect the snake's body. Look back at page 316 to see the skeleton of a snake. Snakes have no arm or leg bones. They move along by moving their backbone from side to side.



Garter snake

Garter snakes are among our most useful snakes. They are found all over the country. You will often find them in gardens and fields. Garter snakes eat animals which are not useful to us. They feed on insects and field mice. These animals often destroy some of our crops.

Sometimes snakes eat birds' eggs or even the young birds. Sometimes they eat frogs and toads. But, most of the time, snakes eat animals which are not very useful to us.

Have you ever happened to see a group of baby snakes together in the spring? Some of these young snakes may have hatched from eggs. Others may have been born alive from their mother's body.

Snakes are very shy animals. If they hear you coming, they move quickly and quietly away. They will not harm you unless you frighten or disturb them.

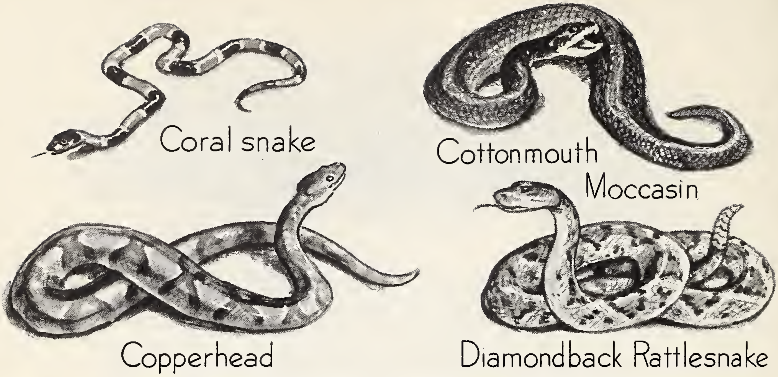
Green snake

Snakes are usually colored in such a way that they are hard to see. Garter snakes and other snakes which live in gardens and meadows are green. It is very hard to see these snakes when they are still, and it is not easy to see them even when they are moving.

Snakes which live on the banks of streams are often dark gray or black in color. Their bodies are very nearly the color of the soil along the banks of streams.

Water snakes are very good swimmers. They dive very gracefully into the water and swim away if you disturb them. As a snake swims along, you can see only its head. It must keep its head above water because it breathes air just as you and I do. A snake would drown if it had too much water in its lungs.

Water snake



The snakes in this picture are the poisonous snakes of the United States. If you frighten them by coming upon them too suddenly, they will try to bite you.

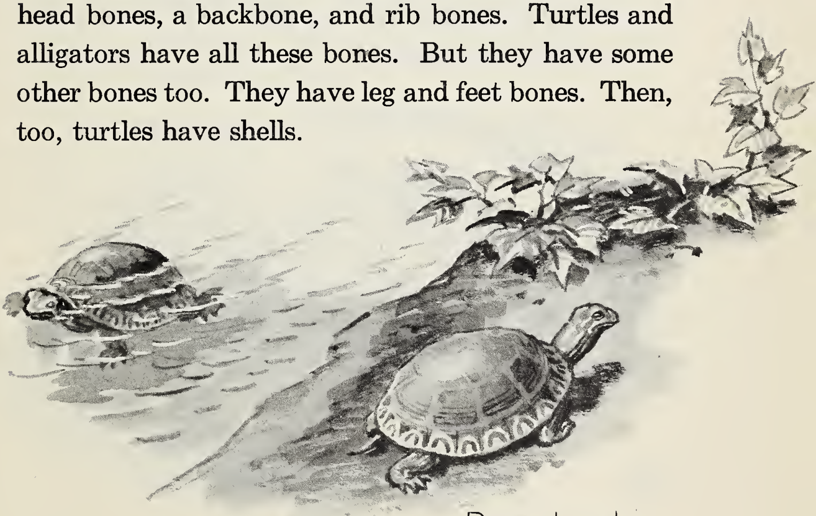
Poisonous snakes have two long, hollow teeth in their upper jaw. These teeth are called fangs. If a snake sticks its fangs into another animal, poison goes down through these fangs into the body of the other animal. If you live in a part of the country where poisonous snakes are found, you should be very careful not to come upon these snakes too suddenly. You should also learn how to take care of snakebite.

Snakes, then, are like other animals in many ways. They are cold-blooded like some animals. They have a skeleton. They must hunt for food. Some of them lay eggs; others do not. They will not harm you unless you frighten them. We should protect most snakes because they are among our most useful animals.

Turtles and alligators belong to the same group of animals as snakes. All these animals are called reptiles. All reptiles are cold-blooded animals. Their body temperature is almost the same as that of the air or water about them.

Reptiles are different from fish, though both are cold-blooded. Fish get their air from the water, you remember. They have gills. Turtles, snakes, and alligators breathe just as we do. They have lungs. Though they are all good swimmers, they must come to the top of the water for air.

Turtles and alligators are like snakes in another way. They have bones in their bodies. Snakes have head bones, a backbone, and rib bones. Turtles and alligators have all these bones. But they have some other bones too. They have leg and feet bones. Then, too, turtles have shells.


Painted turtle

Perhaps you have a turtle at home for a pet. Or you may have one in your schoolroom. A good turtle home should have water and dry soil in it. Turtles have lungs. They must be able to get air. Turtles need dry land as a part of their home so that they can come out of the water and crawl about.

A pet turtle will eat turtle food, which you may buy at a pet shop. Most of this turtle food is called "Ant Eggs." This food is not really ant eggs. It is the cocoon of the ant. As you know, many moths have a resting stage in which they are in a cocoon. This is also true of ants.

Turtles also like tiny pieces of chopped meat and lettuce. Be sure to put a turtle's food in the water. Turtles need water to soften their food so that they can swallow it properly.

This is one of the largest kinds of turtles in the world. This turtle lives in the sea and on islands in the warm Pacific Ocean. These islands are called the Galapagos Islands. They are just west of the northern part of South America.

These turtles are so large that their shells may be three or four feet wide. Perhaps you may have seen some of these turtles in zoos.

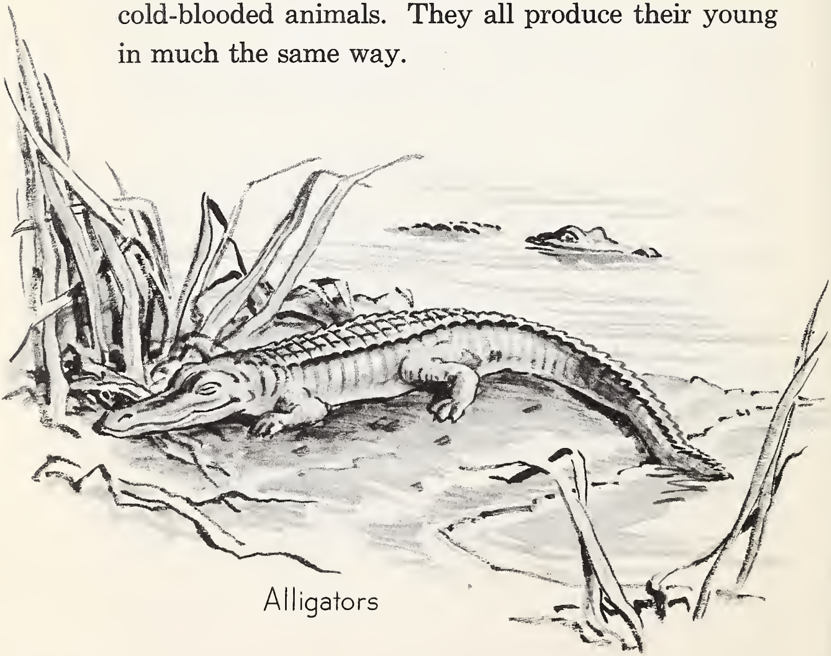
Other kinds of turtles are very small. Their shells may be only an inch or two wide. Some turtles have shells that are grayish in color. Others have dark shells with yellow and red on them. There are many, many different kinds of turtles living all over the world.

In some parts of Florida, alligators live in the warm, quiet streams. They eat small animals which come near them. They catch and hold these animals in their strong jaws.

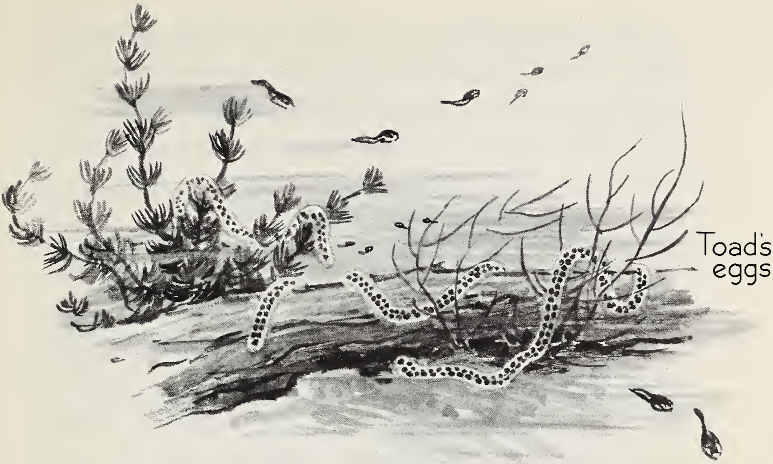
Alligators are very good swimmers. They are hard to see in the water. Their color is much the same as that of the muddy streams in which they live.

Young alligators and turtles are hatched from eggs. The mother animals lay their eggs in a warm, dry, sunny place where they will hatch. Turtles sometimes bury their eggs.

Such reptiles as turtles, snakes, and alligators are much alike. They all have skeletons. They are cold-blooded animals. They all produce their young in much the same way.



Alligators



Changing Animals

All animals change as they grow. The changes that take place are usually those of growing larger. Baby snakes look much like adult snakes except that they are smaller. Baby fish look much like adult fish except that they are smaller.

This is not true of baby toads. Baby toads look nothing like adult toads. The tadpoles in the picture above are baby toads.

Toads are animals which are like snakes and turtles in some ways. Toads are cold-blooded animals. They have skeletons. They hunt for food. They are good swimmers. They lay eggs. But they go through a different kind of change as they grow up.

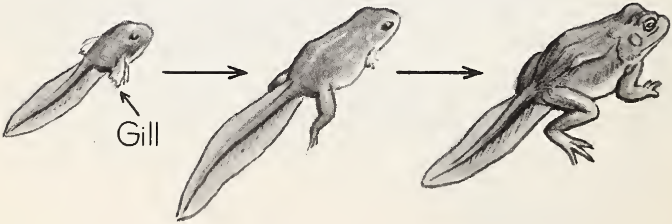
Mother toads do not lay their eggs on dry, warm earth. They lay their eggs in the water. Toads live in the water while they are tadpoles.

As you can see, in the picture on page 331, each toad egg is very small. Mother toads lay strings of these small, black eggs. The eggs are in a jelly-like material. You may find the eggs on the bottom of a shallow pond, or fastened to water plants.

If you find some of these eggs in the spring, bring them to school in a pail of the pond water in which you found them. Keep adding pond water to your pail as the water evaporates into the air.

Pond water makes a better home than tap water for tadpoles because there are many small plants and animals in the water. You cannot see these small plants and animals, but they are there just the same. Young tadpoles feed on these plants and animals.

When young tadpoles first hatch, they are very small. They are able to swim about in the water. They are able to get air from the water. They are also able to get their own food.



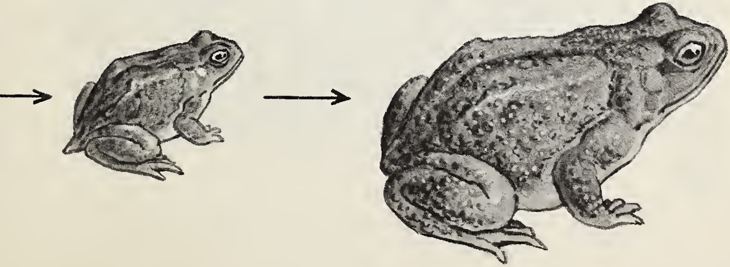
Look at the first picture at the bottom of these two pages. Do you see the little bunchy growths on each side of the tadpole's neck? These are gills. A tadpole uses its gills in the same way as a fish. It takes air from the water with these gills.

Tadpoles lose these outside gills after a few days. Then they use gills which are inside their bodies. Water gets to these gills through a small opening on each side of the head.

After a week or so, tadpoles no longer use their gills to get air. They now have lungs. They can breathe just as we do. Now they must come to the top of the water to get air. For this reason, you must put a large stone in your tadpole home when the tadpoles begin to get legs. They need to put their heads out of the water to get air.

If you look at the pictures at the bottom of these pages, you will notice other changes which take place as a tadpole grows up.

The hind legs appear first. These legs are used by the tadpole in swimming. After a while the left



front leg appears. Then, before long, the right front leg comes out.

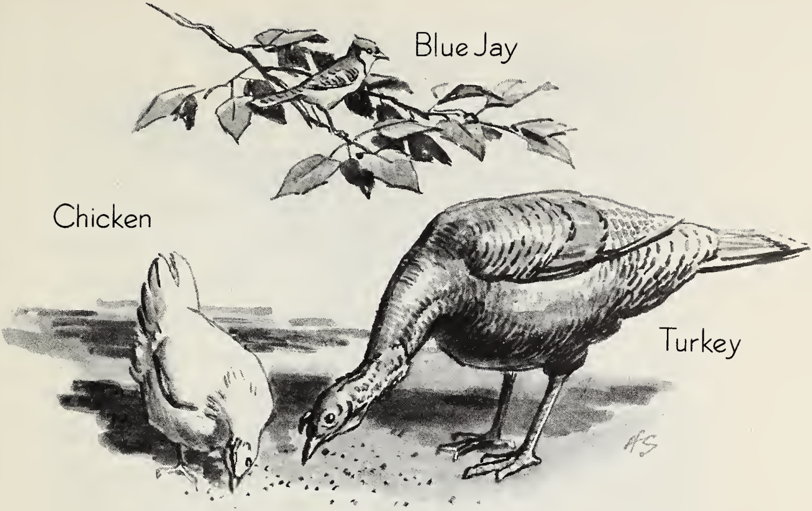
All the time the tadpole's tail is getting shorter and shorter. The tail does not drop off as the tadpole grows into a toad. It is absorbed by the young toad's body and used as food. Young toads have small tails, but after a while they disappear.

The life story of frogs is much the same as that of toads. Try to find some frog's eggs in the spring. Frog's eggs are not laid in strings but in masses of jelly. If you bring frog's eggs to school, be sure to bring plenty of pond water with them.

Frogs and toads belong to a different group of animals from either fish or reptiles. They are called amphibians.

Amphibians are put in a group by themselves because their bodies change so greatly as they grow up. Many amphibians are born in the water. At first they get their air in much the same way as fish. After a while they have lungs. Then they breathe in the same way as reptiles.

Toads and frogs are useful animals. They should never be harmed. They feed on harmful insects. Even when they are tadpoles, they are useful. Tadpoles feed on mosquito wrigglers in the water. If you have a toad in your garden, do not harm it.

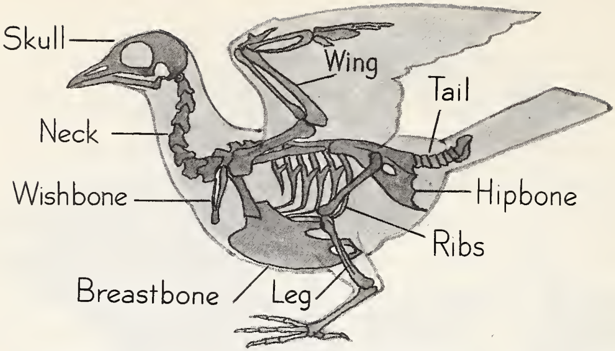


Animals with Feathers

Birds are different from all other animals in one very special way. They have feathers. No other kind of animal has feathers. We say that all animals which have feathers are birds.

You may never have thought of turkeys, geese, chickens, and ducks as birds, but they are. Usually when we say "bird," we think of wild birds, such as blue jays or thrushes or sparrows. How many tame or domesticated birds can you think of? Did you name pigeons, guinea fowls, canaries, or parrots?

Birds are like other animals in several ways. They have skeletons. There are many bones in the body of a bird. These bones are very light.



The bones of a bird must be light so that the bird can fly easily. You know that many birds must migrate long distances each year. The bones of birds are almost hollow. If the bones were solid, they would be much heavier.

Some birds do not fly very well. They can fly for short distances only. Have you ever seen a turkey or a chicken fly? Why do you suppose they cannot fly very well?

Birds are not the only flying animals. Bats can fly, but they are not birds. Grasshoppers and butterflies and mosquitoes can fly, but they are not birds.

There is another great difference between birds and some of the other animals about which you have been reading. Do you remember that fish, reptiles, and amphibians are cold-blooded animals?

Birds are not cold-blooded. We say that they are warm-blooded animals. This means that their bodies are always warm. A bird's body does not become colder if the air around the bird becomes colder. The body does not become warmer if the air around the bird becomes warmer. A bird has about the same temperature all the time.

Of course a bird may have a fever if it is ill. Then the body temperature will be higher.

The body temperature of a bird is higher than ours. It may be between 102 degrees and 110 degrees. When we are well, our body temperature is usually between 98 and 99 degrees.

You know that birds cannot make their own food. They are like other animals in this way. Most birds eat plant food. They eat the fruit and seeds of many different kinds of plants.

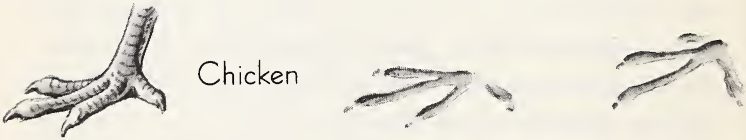
Most birds also eat animal food. They catch insects and use them for food. Birds are very useful to us because of this. Some birds, such as buzzards, feed on dead animals. This is a good thing, too. They help to keep the earth clean in this way.

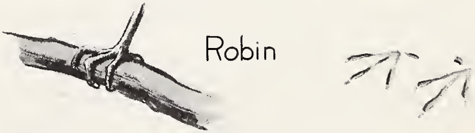
The Feet of Birds. Have you ever noticed the feet of birds? Perhaps you have noticed chicken tracks in the dust of the chicken yard. You may have noticed the tracks of sparrows or chickadees in the snow, or of sandpipers or other shore birds in the wet sand.

The feet of some birds are strong. They are used for walking and scratching. Each toe has a strong nail, or claw, which is used for scratching. How many birds can you name which have feet like the feet of a chicken?

Some birds have feet which can hold on to things tightly. The toes of these birds can curl around the branch of a tree. These toes are strong, too. A bird can hold on to a branch even while it is asleep. A robin has feet like this. Can you think of other birds with strong, curling toes?

Some birds have skin between their toes. These are the web-footed birds, such as ducks. Isn't the track of a duck different from the track of a robin or a chicken? Webbed feet are good for swimming.



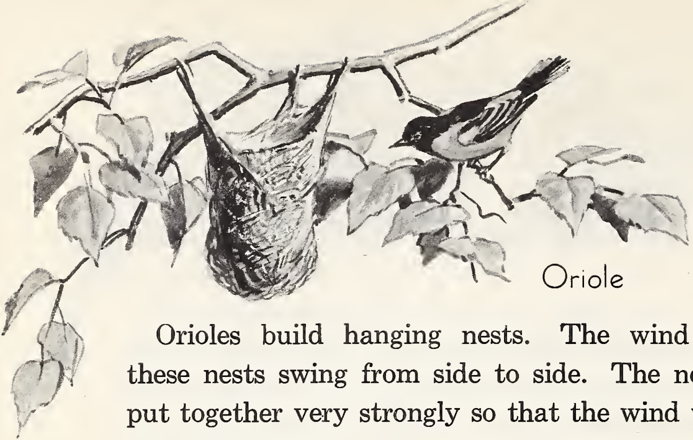


The Nests of Birds. Almost all birds build nests. There are only a few which do not. But not all nest-building birds build the same kinds of nests.

Different kinds of birds build different kinds of nests. However, birds which are alike build almost the same kind of nest. In other words, robins build nests which look alike, although some robin nests may be smaller than others.

You may be interested in making a collection of birds' nests. There is one very important thing to remember if you wish to make such a collection. The nests must never be taken except in the late fall or winter. At this time of year the birds are no longer using their nests.

Should you know where to look for birds' nests? Of course you will find many of them in trees. Robins often build their nests in trees. The outside of the nest is made of sticks and mud. Robins line their nests with soft string or bits of paper. The nests are protected from rain by the leaves over them.



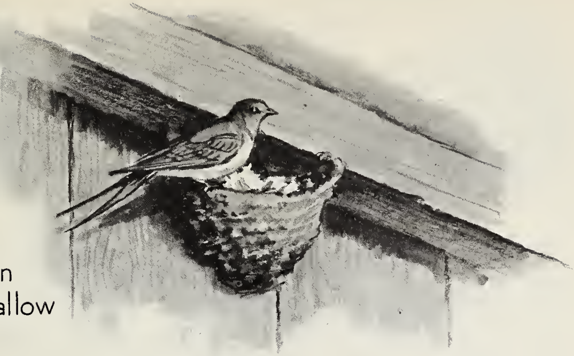
Oriole

Orioles build hanging nests. The wind makes these nests swing from side to side. The nests are put together very strongly so that the wind will not blow them apart.

Woodpeckers also build their nests in trees, but you cannot find these nests easily. They are built inside a tree trunk. This makes a snug, safe place for the baby birds.

Not all birds build their nests in trees. Quail and pheasants make their nests on the ground. These nests are very well hidden in the grass. Sometimes these birds build nests in wheat fields. As the farmer is harvesting his grain, he sometimes sees birds fly up out of the grass. Then he can run his machine around this place in the wheat field so as not to harm the nest.

Quail



Barn swallow

If there is a stream near your home or school, and it has high banks, look along the banks for birds' nests. Some birds build their nests in holes in the banks of a stream.

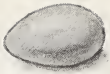
Be sure to look in your barn for the nests of barn swallows. You will probably be able to find many of their nests.

These are only a few of the different kinds of nests which birds build. You will probably be able to find many, many different kinds of nests.

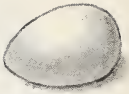
However, you will never find the nests of some birds, because they build no nests. Cowbirds never build nests. They do not need them, since they lay their eggs in the nests of other birds.

The Eggs of Birds. Different kinds of birds lay eggs of different sizes and colors. A chicken's egg looks quite different from a robin's egg. The chicken's egg is white or brown. The robin's egg is blue.

Chicken egg



Robin egg



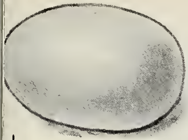
Quail egg

Though the eggs of birds are of many different sizes and colors, they are all very much alike inside. You know what a chicken's egg is like inside. It has a white and a yolk. The baby chicken begins its life as a very small part of the yolk. In fact, it is so small that you would be able to see it only with a microscope.

The yolks of eggs are really stored food for the baby birds. Their bodies absorb this food while they are in the egg.

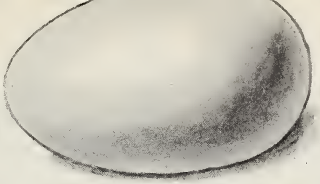
All birds lay eggs. No bird is ever born alive in the way that some snakes and fish are born alive. Female birds are very busy mothers. They do not leave their eggs to be warmed by the sun so that they will hatch. Mother birds keep the eggs warm with their own bodies. Sometimes father birds keep the eggs warm while the mother bird hunts for food.

Different kinds of birds have to keep their eggs warm for different lengths of time before they will hatch. It takes twenty-one days for chickens to hatch. Goose eggs must be kept warm for thirty days. Robins' eggs hatch in only fourteen days.



l egg

Hummingbird egg



Goose egg

The work of the mother and father birds is not ended when the young birds are hatched. Baby birds must be cared for. They eat a great deal of food.

A few baby birds can hunt for food in a few days after they are hatched. Baby chickens and baby quail are able to follow their mothers around after a day or so. But they do not really hunt for food themselves. They follow their mother and wait for her to show them the food. Have you ever watched hens hunting food for their babies?

Young robins and wrens and owls, as well as many other birds, stay in the nest and wait for food to be brought to them. If you can find a nest where there are baby birds, watch the mother and father birds as they bring food to their babies. They make many, many trips.

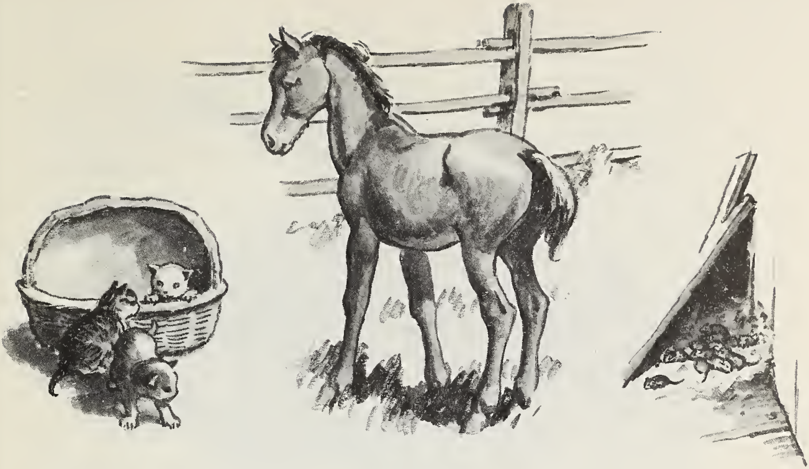
Chickens and ducks and quail have many soft, downy feathers when they are hatched. Some birds, such as robins, have almost no feathers. They must be kept warm. They cannot fly until their feathers grow. Birds are good parents. Most of them build nests and care for their young until they are strong.

Other Warm-blooded Animals

The animals on these two pages all belong to the same group. They are like other groups of animals in some ways and quite different in other ways. These animals are like many other animals because they have strong skeletons.

These animals, and the animals we call birds, are different from some other animals because they are warm-blooded. Their body temperatures do not change when the temperature of the air or water around them changes.

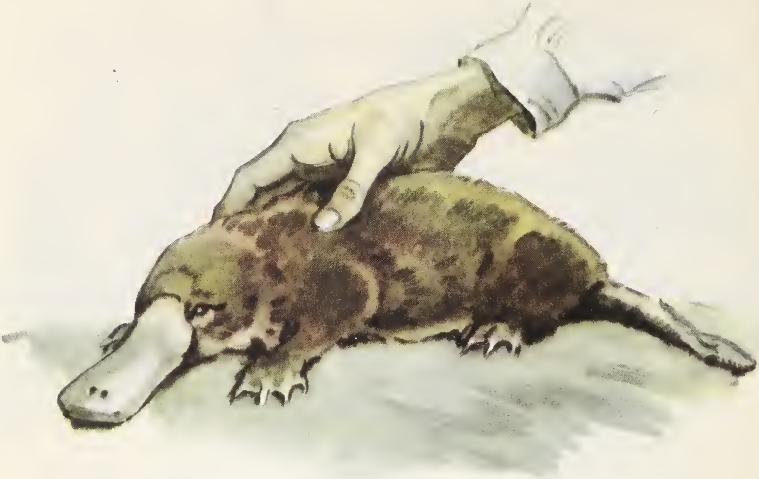
However, these animals are very different from birds in two ways. First, all these animals feed on milk from the mother's body when they are babies.



Dogs, cats, mice, rabbits, horses, cows, pigs, wolves, foxes, bears, deer, elephants, whales, bats, and many other animals feed on the mother's milk when they are young. All these animals belong to one group. We call them mammals.

There is another difference between mammals and all other animals. Mammals have hair on their bodies. Horses, cows, and seals have hair on their bodies. Sheep have much thicker hair. We call their hair wool.

Seals, minks, muskrats, beavers, and leopards are killed because they have such beautiful coats of hair. We call this hair fur and use it for coats, muffs, and scarves. Name some other mammals which have beautiful, thick coats of hair.



Many mammals are very helpless when they are first born. Kittens, puppies, and mice are blind when they are born. Their mothers take good care of them. They keep them warm and protect them from danger.

Most mammals bear their young alive. That is, they do not lay eggs. The mammal shown at the top of this page is one of the two mammals we know about that does lay eggs. This mammal lives in Australia. The other egg-laying mammal is the spiny anteater, which lives in Australia, too.

Even these mammals, which lay eggs, take good care of their young after they hatch from the eggs. They keep them warm, protect them from enemies, and feed them milk, just as other mammals do.

Some mammals carry their babies around with them for a while after they are born. The mother opossum carries her babies around with her for about eight weeks after they are born. Sometimes the mother opossum has a second group of babies before the first ones are ready to leave her. When this happens, the older babies are carried on her back. The younger ones are carried on the underside of her body.

All baby mammals look a great deal like their parents. They are not as large, of course. However, you would know that a puppy was a dog because it looks much like a full-grown dog. This is true of mice and cows too. Mammals change as they grow up, but the changes are not as great as the changes in the body of a toad or a frog.

Think of all the animals you have read about. Think of one-celled animals, of fish, of reptiles, of amphibians, of birds, and of mammals. How are these animals alike? How are they different?

SOMETHING FOR YOU

1. You know some ways in which all animals are alike. Now think of some ways in which animals are like plants. What are some of the things which both animals and plants need to live and grow?

2. Are you interested in snakes? If you are, find stories about snakes of other lands. In South and Central America there are huge snakes which are sometimes twelve feet in length. They are called boa constrictors. These snakes are not poisonous. In India there are poisonous snakes called cobras. Read about these snakes.

Find out which are the poisonous snakes in your part of the country. If there is a reptile house near you, visit this house so that you will know the poisonous snakes. If you cannot do this, get pictures of such snakes and learn to recognize them.

3. Have you ever heard anyone say that toads cause you to have warts? This is not true. It is just a superstition. Toads do give off a bitter-tasting liquid if they are frightened. This is a way of protecting themselves. A dog sometimes tries to eat toads. When it does, the toad gives off the bitter-tasting liquid. You may be sure that the dog quickly drops the toad and leaves it alone.

4. Do you like to watch birds? If you do, then make a feeding station. Make a flat wooden shelf outside your window. The shelf could be about as long as the width of the window and about two feet wide. A glass cover over the shelf would be good to keep rain or snow off the birds' food. The glass cover should be about six inches above the shelf. Put grain and sunflower seeds on the feeding station each day.

Some birds like peanut butter. Get a piece of birch or some other soft wood about two feet long. Bore holes about an inch deep in the wood and about half an inch in diameter. Fill the holes with peanut butter. Hang the wood by a long wire from a tree branch. This is a good bird-feeder because cats and squirrels cannot reach it. Be careful not to frighten the birds when they come.

5. Make a chart like this one and fill in the spaces:

Animal	Warm-blooded or Cold-blooded	Kind of Skeleton	How It Gets Air	Body Covering	How It Is Born
One-celled animal					
Worm					
Reptile					
Fish					
Amphibian					
Bird					
Mammal					

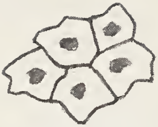
People Are Planners

You and Other Living Things

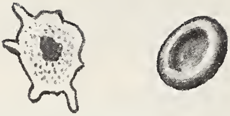
There is one kind of living thing more interesting than any other to us. This is the living thing which we call a person.

You yourself are very much alive. You like to run and play. You need food and air. In this way you are very much like other animals. People cannot make their own food. Of course they have learned to cook food. Your mother cooks meat and vegetables, but she cannot make meat and vegetables.

We must depend on plants and other animals for our food supply. We raise these living things for use as food.



Skin cells



Blood cells

Our bodies are like the bodies of other animals in a great many ways. We have strong skeletons, which support our bodies. Our bodies are made of millions of tiny cells. Each of these cells is made of protoplasm. You know that the cells of any living thing are made of protoplasm.

Suppose you could look at some of the cells of your body under a microscope. Then you might see some of the cells shown above.

Yes, you are like other animals in several ways. You must have food and air to live and grow. Your body is made of cells. There is a strong skeleton inside your body.

Could you think which group of animals you are most like? You certainly aren't very much like a fish. Fish live all their lives in water. They get air from the water.

Your body isn't like that of a reptile. For one thing, reptiles are cold-blooded animals. Their body temperature changes all the time. We are warm-blooded. Our temperature stays the same unless we become ill.

Nor are you like an amphibian. Amphibians go through great body changes as they grow up. First they are able to live in the water very much as fish do. Then their lungs develop, and they breathe air as we do.

We can fly in the airplanes which man has invented. However, we cannot fly as freely as birds fly. Then, of course, we do not have feathers. Certainly our bodies are not very much like the bodies of birds.

Now let us think about mammals for a moment. Are we like these animals in any way? Mammals have lungs all their lives and use these lungs for breathing. So do we. Mammals have hair on their bodies. So do we. Mammals feed their young on milk. So do people.

Scientists who study animals say that we belong to the mammal group of animals. Our bodies are very much like those of other mammals. There is one great difference, however, between people and other mammals. We are planners.

Children begin to plan

People begin to think and plan when they are very young. Little children learn how to build with blocks. Later on they learn to help their mothers around the house. They can follow directions.

Soon they begin to go to school. School is a place which should help you to be a better planner. You learn to work with others. This is the beginning of good planning. You are able to listen to other ideas. Then you give your ideas to the group. The whole group plans together.

Reading helps you in planning, too. You are able to use information which other people have discovered. New ideas come to you from books. It is a very wonderful thing to be able to get information by reading. Did you know that people are the only living things who can learn things by reading?

What are some other things you can do because you have a good brain? You can write, of course. Do you send ideas to people in other cities? This can be done by writing letters.

One of the most important things which we can do and which no other animals can do is talk to one another. Have you ever thought about that? Your dog sometimes seems to understand what you say to him. However, he can never say to you that he understands. Many scientists think that people have not always been able to talk to one another. They had to invent languages before they could do this.

The sounds we make in speaking are very interesting. The same sound may mean different things to different groups of people. Pronounce this letter softly to yourself: *e*. When you say *e* in the English language, you usually think of a letter.

The sound that you give the letter *e* would mean "and" to a Spanish-speaking child. *Buenas noches* means "Good night" in Spanish. You may not understand the Spanish language. That is not too important.

However, this is important. When the people of different groups cannot understand each other, it still remains true that they have brains. They can learn to understand each other by learning each other's language.

Planning for Animals

People have lived in North America for a long, long time. The people who first lived here, so far as we know, were Indians. Indians are the true native Americans.

Indians have been living in North America for hundreds and hundreds of years. White people began to come to this country to live only about four hundred years ago.

There were a great many wild birds and mammals living in North America before the white man came. Deer, foxes, wolves, lions, rabbits, bears, weasels, and many, many other animals roamed the forests.

In the forests and grasslands, turkeys, partridges, quail, and doves lived. Thousands and thousands of wild ducks and geese lived in the marshy lands. Huge herds of buffaloes lived on the grassy plains.

Some of these animals were killed by the Indians. Every year the Indians who lived on the plains hunted the buffaloes. They killed these animals with bows and arrows. Buffaloes were not hunted and killed just for fun. Indians used them as food.

Other animals were killed for food or for clothing or for both. Indians used the skin and fur of animals for clothing and for summer tents: You see, Indians were killers of wild animals, but they killed these animals because they needed to.

Though many birds and mammals were killed by Indians, there were still thousands and thousands of wild animals left when the white man came. One reason was that there were not a great many Indians living in this huge country of North America.

The first white men who came to this country killed wisely, too. They also killed only for food and clothing. There were many fish, many birds, and many mammals to use for food. It was right for man to make good use of these animals.

After a while the white man began to kill wild animals just for the fun of killing. He now had plenty of domesticated animals to use for food. He raised chickens and pigs and cattle for food. He had plenty of eggs, butter, milk, and cheese. Man did not need to hunt the wild animals as much as he did before.

For a while man did not see any harm in killing for the fun of it. Then he began to notice that the deer were disappearing from the forests. Very few buffaloes roamed the grassy plains. He began to realize that something must be done.

Finally man began to plan for other animals. He wanted deer in the forests. He wanted fish in the streams. He wanted ducks and geese in the marshes. If these animals were to stay, he had to protect them; he had to plan for them. So he did.

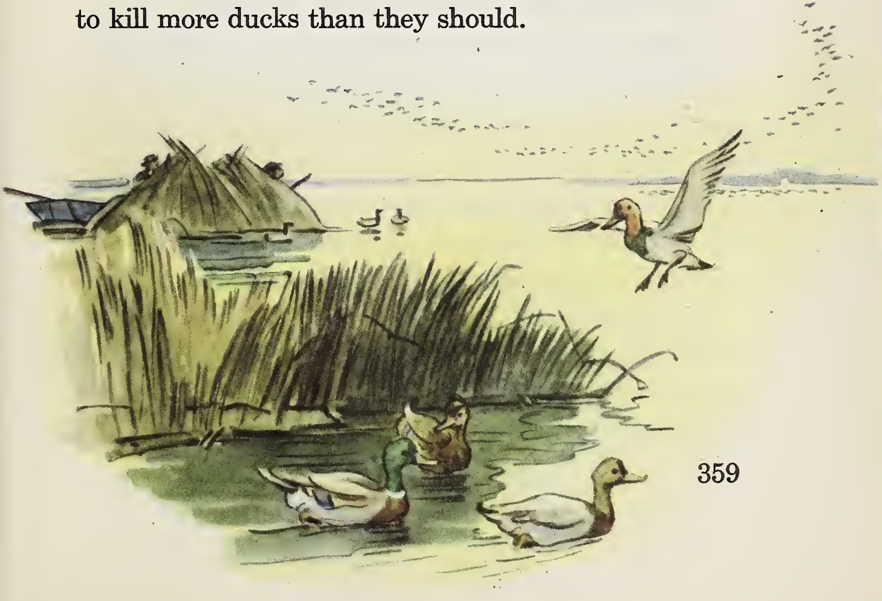
People got together in groups and talked about how to protect wild life. They decided that laws must be passed to protect wild animals. Laws were made and passed. Deer, doves, quail, geese, ducks, and many other animals may be hunted only at certain times of the year.

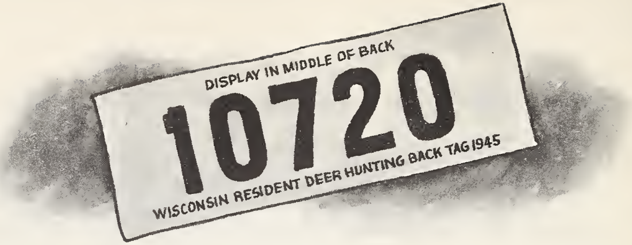
Do you think people should be allowed to hunt ducks while the mother ducks are hatching their eggs? Do you think people should be allowed to hunt ducks before the ducklings are full-grown?

Wild ducks are protected from the hunter most of the year. Ducks may be killed in the fall. By that time of the year, all the ducklings have been hatched. The mother and father ducks no longer have to care for their young.

Ducks are protected in another way too. A hunter is not allowed to kill as many ducks as he can. Each hunter is allowed to kill only a few ducks during the hunting season. Laws have been passed which tell how many ducks may be killed by each hunter.

You may wonder how these laws are enforced. Many hunters are good sportsmen, and do not try to kill more ducks than they should.




DISPLAY IN MIDDLE OF BACK
10720
WISCONSIN RESIDENT DEER HUNTING BACK TAG 1945

However, some hunters are poor sportsmen, and there are "wild-life policemen" to watch for them. These policemen are called game wardens. They see to it that no hunters kill too many ducks.

Other wild animals are protected in the same way that ducks are protected. Hunters and fishermen must get a license before they are allowed to hunt and fish. They must keep this license with them while they are hunting and fishing. If a game warden asks to see the license, they must show it to him.

There are good reasons why everyone should buy a license before he hunts or fishes. In this way, the game wardens know how many people will be hunting or fishing for a certain kind of animal each year. Then they can decide how many of that kind of animal may be taken by each person. In this way, we shall always have wild animals in our country.

In some states certain wild animals may not be killed. This is because that kind of animal has become very scarce. No one may kill such an animal until more are born and become full-grown animals.

Homes for Wild Animals

We are learning to protect wild animals in another way. For a long time the white man destroyed the homes of other animals. He did not mean to do this. He just didn't think.

The great forests of North America were the homes of millions of wild animals. These animals could live nowhere except in the forests. They could hide from their enemies in the bushes and among the trees. They found the best homes in the forests. They found good food there, too.

When the white man began to cut down the forests, he destroyed the homes of these animals. Many baby animals never lived to be full-grown. They could not escape their enemies.

Now we have learned to protect these animals of the forests. Laws have been passed which forbid the hunting of animals in certain forest areas. Our national government and many state governments have kept these areas as homes for wild forest animals.

When the white man began to cut the grass on the great plains of North America, he destroyed the food and homes of some of the wild animals. Great herds of buffaloes fed on the tall grass of these regions. When the grass was cut and the land was plowed, there was not enough food for these animals. They began to die out. There were fewer and fewer of these animals each year.

After a while people began to realize what was happening. They set aside certain grasslands as grazing lands for the herds of buffaloes. No one could kill these animals. No one could destroy their food by plowing the land to raise wheat or corn. Because we were finally wise enough to set aside these lands, there are still buffaloes in North America today.

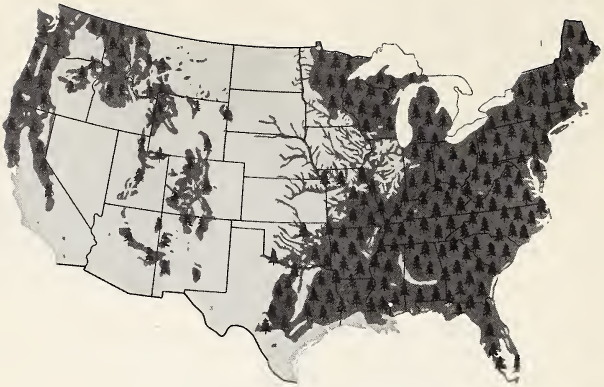
The homes of many grassland birds were destroyed when the grassy plains were plowed for farming. Quail and doves made their homes in these regions.

Farmers liked to keep their land clean and neat. They allowed no grass or bushes to grow between their fields of corn and wheat and rye. There were no homes for the grassland birds.

After a while the farmers realized this. Then they began to let the bushes, vines, and grass grow along the fences between the fields. Now there were homes for quail, doves, and other birds, as is shown in the picture on the opposite page.

Birds are protected in other ways too. No one is allowed to hunt certain birds which are scarce. Then there are special homes set aside for birds. These homes are called bird sanctuaries.

Some bird sanctuaries are in marshy places. Here ducks and geese may feed and rest safely. No hunting is allowed. Sanctuaries for forest birds are also set aside. People may walk through these lovely places, but they are not allowed to harm the birds.

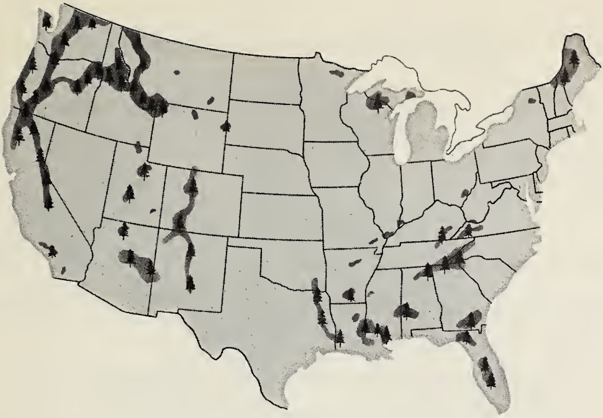


Planning for Plants

About two hundred years ago there were a great many forest areas in the United States. The map above shows how much of the land was covered with trees. On the opposite page you can see how much of the land is covered with forests today. In two hundred years many of our forests have been cut down.

The early settlers of this country needed the lumber from these forests. They needed lumber to build their homes. They needed wood to warm their homes and cook their food. They needed strong wood to build their ships.

Trouble came when we continued to cut down our trees. We began to realize that soon there would be little wood left for cutting; so man began to plan.



Some of the forest land was bought by our national and state governments. No one could cut trees in these forests without permission. Plans were worked out for these and other forests so that we should know the best ways to cut trees.

For a long time every tree was cut down in certain areas. Old trees and young trees were cut. Today we follow better forest practices. Only the older trees are cut. Young trees are left standing and grow still more.

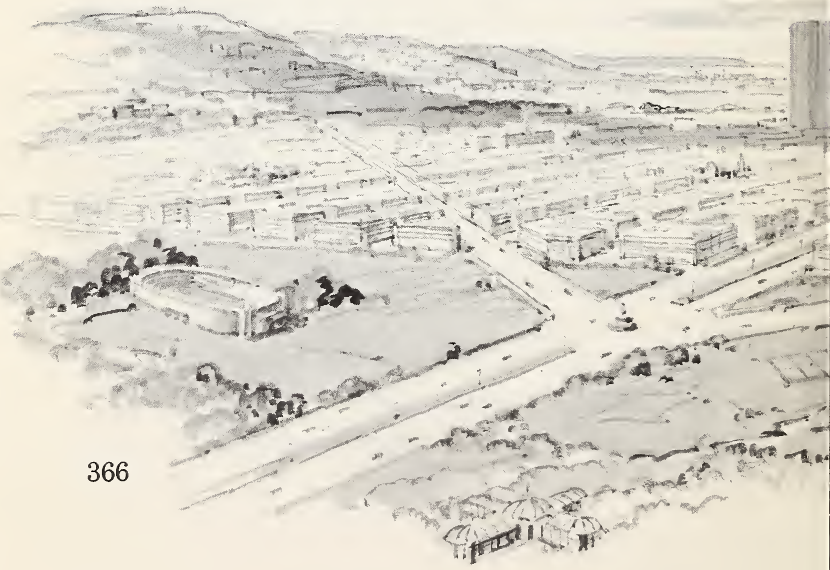
Then, too, we are beginning to plant trees in our forests. Whenever a tree is cut, a young tree is planted to grow in its place. In this way, we are protecting our forests. If we continue good forest practices, we shall always have enough lumber.

Planning for Ourselves

We are planners. We are planners because we are thinkers. Man is able to plan for good farms. He is able to use land wisely to raise food plants.

Farmers know that people need meat for food; so they raise pigs, from which we get our pork. They raise sheep, from which we get our lamb. They raise cattle, from which we get our beef.

We can learn things quickly if we wish to do so. It is easy to write down things which we have learned. We read. We read about things that other people have done, and in this way we learn how to do new things ourselves. No other animal can do this.



Because we have a better brain than other animals, we can make sounds mean something. We like to talk to other people, tell them what we think, what we have seen, or read, or learned. It is possible to learn to speak other languages so that we may know what other groups of people are thinking.

Great cities have been built by planning. The more carefully we plan, the more beautiful a city may become. It is possible to build a city where there is plenty of living space for everyone. It is possible to build a city where there is plenty of room for children to play, a city where it is easy to travel from one place to another.

Man has learned to use tools with which he builds tall, strong buildings. Perhaps soon he will plan these buildings so carefully that the cities will be as open and beautiful as the one on pages 366 and 367. Yes, people are different from all other animals because they are able to think and plan.

All people are alike because they can plan. People all over the world are making plans for themselves. These plans may be a little different from ours.

Perhaps someone in your neighborhood is planning to build a house. He may plan to build a brick house. Perhaps someone living in the jungles of Brazil is planning to build a house. That person may plan to build his house of slender tree trunks and large leaves. Though the plans for different houses differ, the plans for each house are made by people who are thinking.

All people all over the world are alike in this way. They are planners. People may have different skin colors. Their languages may not be the same. Their customs may be very different from ours.

However, we are really like everyone else. We should all be able to plan and work together. All people everywhere should help in trying to make the very best use of the world around them. One of the most important things that you will ever have to do is to learn to plan well with others.

SOMETHING FOR YOU

1. Have you ever destroyed lovely wild flowers, such as the lady's-slipper and trillium shown in this picture? Many wild flowers are beautiful. People like to pick them and take them home. Often the flowers are not good for cutting and making bouquets. They wilt and die soon after they have been picked.

Find out if there are any wild flowers which are protected in your state. Do not pick them.

2. Find out how wild animals are protected in your state. Write your state game commission to learn which animals are protected. Ask for the dates of the open seasons for hunting certain animals. Ask how many of each animal a hunter may take.

3. We alone, of all living things, are able to plan for ourselves. Think of things that you do to keep your body healthy and strong. Look at these pictures for ideas.

4. If you live on a farm, ask your father to tell you about the things he does to protect the land, to protect the trees, and to protect the birds on his farm.

5. There may be a bird sanctuary, a grassland reservation, or a forest reservation near you. If there is, try to visit it.

6. You might like to know how much forest land is owned by your state or by our national government in your state. Write your state forestry bureau to get this information.

7. Many, many trees are destroyed each year by fire. What fire-prevention rules should you practice when you are on a picnic?

8. Think of ways in which people can learn to live together in a better way by planning.

Science Words

This part of your book is a science dictionary. It will help you find the meanings of words which are used in your book. The page number following each word shows you on what page the word is first found.

The following list of letter sounds will help you to use correctly the markings of your science words.

ă *as in* căt
ā *as in* māde
ȧ *as in* grȧss
â *as in* câre
ä *as in* bärn

ĕ *as in* nĕt
ē *as in* hē

ẽ *as in* hẽr
ė *as in* bėgin

ĭ *as in* gĭft
ī *as in* rīde

ŏ *as in* tŏp
ō *as in* jōke

ô *as in* hôrse
ȯ *as in* ȯbey
ŏ̂ *as in* sŏ̂ft

ŭ *as in* cŭp
ū *as in* mūsic
û *as in* bûrn
ū̇ *as in* ū̇nite

oi *as in* soil
o͝o *as in* to͝ok
o͞o *as in* mo͞on
ng *as in* sing
th *as in* thin
~~th~~ *as in* ~~th~~at
t͜ū *as in* pict͜ūre

ab sorb′ (ăb sôrb′). To take up or suck up as a blotter takes up ink (p. 125)

al′gae (ăl′jē). A group of green plants. Some of these plants live in salt water, some in fresh water, and some on the land (p. 282)

am phib′i an (ăm fĭb′ĭ ăn). A group of animals having a backbone and which get air from the water during the first part of their lives. Later these animals have lungs and get air as we do. Frogs and toads belong to this group of animals (p. 334)

an e mom′e ter (ăn ė mŏm′ė tẽr). An instrument which measures the speed of the wind (p. 220)

an′er oid ba rom′e ter (ăn′ẽr oid bȧ rŏm′ė tẽr). An instrument which measures air pressure. This kind of barometer uses no liquid (p. 213)

an′ther (ăn′thẽr). The part of a stamen in a flower which makes pollen (p. 294)

a quar′i um (ȧ kwâr′ĭ ŭm). A tank in which to keep water plants and animals (p. 195)

ax′is (ăk′sĭs). The imaginary straight line from the north pole through the center of the earth to the south pole. The earth rotates upon its axis (p. 45)

ba rom′e ter (bȧ rŏm′ė tẽr). An instrument which measures air pressure (p. 213)

bud (bŭd). The part of a stem or twig where the new leaves and flowers are found. Buds usually open in the spring (p. 60)

bulb (bŭlb). A large bud, usually formed under the ground, with roots and a short thick stem. Onions, lilies, and tulips grow from bulbs (p. 59)

car′bon di ox′ide (kär′bŏn dī ŏk′sīd). One of the gases found in the air. It is used by green plants to make food (p. 271)
cell (sĕl). Every living thing is made up of one or more cells (p. 269)
chlo′ro phyll (klō′rō̇ fĭl). The green coloring matter in plants which is used in food-making (p. 271)
chrys′a lis (krĭs′ȧ lĭs). The covering of a butterfly when it is in the third, or resting, stage of its life (p. 75)
cir′cuit (sûr′kĭt). A path for electricity (p. 252)
cir′cu late (sûr′kū̇ lāt). To move around in such a way as to come back to the starting point (p. 26)
cli′mate (klī′mĭt). The average condition of the weather at any place (p. 96)
co coon′ (kŏ ko͞on′). The silky shell, or case, spun by the caterpillars of some insects, especially moths. Moths spend the third stage of their lives in a cocoon (p. 75)
cold′-blood′ed an′i mal (kōld′-blŭd′ĕd ăn′ĭ măl). An animal whose blood is about the same temperature as the water or air around it. Snakes, frogs, and fish are cold-blooded animals (p. 320)
col′o ny (kŏl′ō̇ nĭ). A number of plants or animals of the same kind living together in a group (p. 283)
con dense′ (kŏn dĕns′). To come together into a smaller space (p. 25)
con duct′ (kŏn dŭkt′). To be the means of sending heat or electricity from one place to another (p. 27)
cur′rent (kûr′ĕnt). A flowing or moving onward, somewhat like a stream (p. 192)

de cay′ (dē̇ kā′). To spoil or rot or waste away (p. 291)
de gree′ (dē̇ grē′). A division, or space, marked on a thermometer (p. 10)
des′ert (dĕz′ẽrt). Any part of the earth where there is very little plant life. There is not enough water in a desert for plants to grow well (p. 118)
di am′e ter (dī ăm′ē̇ tẽr). A line through the center of anything (p. 8)
dis solve′ (dĭ zŏlv′). To become a part of a liquid (p. 21)
do mes′ti cat ed (dō̇ mĕs′tĭ kāt ĕd). Tamed. Horses, cows, dogs, and cats are domesticated animals (p. 289)

dry cell (drī sĕl). Chemicals in a sealed container which produce electricity. Dry cells are used in flashlights (p. 252)

egg cell (ĕg sĕl). The cell in a plant which may, when fertilized, develop into a seed (p. 294)
e lec tro mag′net (ē̇ lĕk trō̇ măg′nĕt). A magnet made by winding an insulated wire around a piece of soft iron. When electricity goes through the wire, the iron becomes a magnet (p. 251)
en′er gy (ĕn′ẽr jĭ). The power to *do* something. Heat, light, and electricity are forms of energy (p. 279)
e qua′tor (ē̇ kwā′tẽr). An imaginary circle on the surface of the earth, which is exactly half way between the north and south poles (p. 146)
es′ti mate (ĕs′tĭ māt). To make the best guess possible (p. 225)
e vap′o rate (ē̇ văp′ō̇ rāt). To change into a gas (p. 24)
ex per′i ment (ĕks pĕr′ĭ mĕnt). A trial made to prove or disprove something (p. 25)

fer′tile (fûr′tĭl). Able to produce much. Good, rich soil on which plants will grow well is said to be fertile soil (p. 121)
fer ti li za′tion (fûr tĭ lĭ zā′shŭn). The union of a female and a male germ cell to form a new plant or animal (p. 295)
flint (flĭnt). A very hard kind of quartz. Quartz is a kind of rock (p. 18)
fore′cast (fōr′kȧst). To tell about a happening before it takes place. A person who tells what the weather will be is said to forecast the weather (p. 210)
frost line (frŏ̇st līn). An imaginary line below the surface of the soil. Above this line the water in the soil will freeze during the coldest winter days (p. 93)

gale (gāl). A very strong wind which has a speed of between 35 and 75 miles an hour (p. 206)
gas (găs). The state of a substance in which it holds no definite shape or volume of its own. Air is made up of such gases as oxygen, carbon dioxide, nitrogen, and water vapor (p. 11)
germ (jûrm). Any disease-producing plant or animal which can be seen only with a microscope (p. 22)
gill (gĭl). The part of the body of some water-living animals which is used to take in air under water (p. 318)
Gulf Stream (gŭlf strēm). A warm current of the North Atlantic Ocean. It moves northward from the Gulf of Mexico to Cape Cod; then it moves toward the British Isles (p. 113)

hi ber na′tion (hī bẽr nā′shŭn). Passing all or part of the winter in a resting or sleeping state (p. 91)

hi ber na′tor (hī bẽr nā′tẽr). An animal which spends all winter in a resting or sleeping state (p. 91)

high′-pres′sure a′re a (hī′-prĕsh′ẽr ā′rē̇ ȧ). A place where the air pressure is highest (p. 224)

hur′ri cane (hûr′ĭ kān). A bad storm, beginning over the ocean, with winds up to 100 miles an hour (p. 206)

in′sect (ĭn′sĕkt). An animal with six legs (p. 72)

in′su lat ed (ĭn′sū̇ lāt ĕd). Prepared in such a way that electricity will not pass out of the material. A copper wire wound with silk or cotton thread is an insulated wire. Electricity will pass through the copper wire but will not pass out through the thread (p. 252)

i′ron fil′ing (ī′ẽrn fīl′ĭng). A very small piece of iron (p. 236)

ir′ri gate (ĭr′ĭ gāt). To cause a stream of water to flow upon, over, or through the land (p. 126)

Lab′ra dor Cur′rent (lăb′rȧ dôr kûr′ĕnt). A cold ocean stream flowing southward from the north pole between Greenland and North America (p. 113)

lar′va (lär′vȧ). The wormlike form in which certain insects hatch from the egg and in which they remain until they form a chrysalis or cocoon. A caterpillar is a larva (p. 321)

leaf scar (lēf skär). A mark left on a stem after a leaf has fallen (p. 66)

liq′uid (lĭk′wĭd). The state of a substance in which it holds no definite shape but does hold a definite volume. Water, oil, gasoline, and melted lead are liquids (p. 19)

lo co mo′tive (lō kō̇ mō′tĭv). An engine or electric motor used to haul cars on a railroad (p. 156)

low′-pres′sure a′re a (lō′-prĕsh′ẽr ā′rē̇ ȧ). A place where the air pressure is lowest (p. 224)

mag net′ic field (măg nĕt′ĭk fēld). The space around a magnet through which a magnet pulls iron or steel toward itself (p. 239)

mag net′ic pole (măg nĕt′ĭk pōl). Either of two spots on the earth's surface toward which a compass needle points. These two spots are called the north magnetic pole and the south magnetic pole (p. 245)

mag′net ize (măg′nĕ tīz). To cause a piece of iron or steel to become a magnet (p. 230)

mag′ni fy ing glass (măg′nĭ fī ĭng glȧs). A specially made piece of glass which makes an object appear to be larger than it really is (p. 278)

ma lar′i a (mȧ lâr′ĭ ȧ). A disease caused by the bite of a certain kind of mosquito (p. 145)

mam′mal (măm′ăl). Any animal whose young is fed milk from its mother's body (p. 345)

mer′cu ry (mûr′kŭ̇ rĭ). A heavy, silver-white metal which is liquid at ordinary temperatures. Mercury is used in some thermometers (p. 10)

mi′cro scope (mī′krō̇ skōp). An instrument which makes a very small object look big (p. 234)

mi′grate (mī′grāt). To travel at regular times from one place to another (p. 78)

mold (mōld). A small plant which grows on decaying plant or animal material (p. 272)

mol′e cule (mŏl′ē̇ kūl). A very small, invisible particle of a substance (p. 233)

nec′tar (nĕk′tẽr). A sweet liquid produced in the flower of a plant (p. 81)

north pole of mag′net (nôrth pōl ŏv măg′nĕt). The end of a magnet which points toward the north magnetic pole of the earth (p. 234)

North Star (nôrth stär). The star toward which the north end of the axis of the earth points (p. 45)

o a′sis (ō̇ ā′sĭs). A place in a desert where there is enough water for trees and plants to grow (p. 121)

o′pen sea′son (ō′pĕn sē′z′n). The time of the year during which a person may hunt or fish (p. 369)

par′ti cle (pär′tĭ k′l). A very, very small part of anything (p. 233)

pen i cil′lin (pĕn ĭ sĭl′ĭn). A medicine made from a certain kind of mold, which is used to kill certain disease-producing plants and animals (p. 288)

pet′al (pĕt″l). The white or colored leaves at the base of a flower (p. 292)

pis′til (pĭs′tĭl). The part of a plant in which the egg cells grow. Pollen falls on the top of the pistil and grows down through it to reach the egg cells (p. 294)

pol′len (pŏl′ĕn). The yellow dust produced by seed-producing plants. Pollen contains sperm cells, which fertilize egg cells (p. 288)

pres′sure (prĕṣh′ẽr). A push (p. 187)

pro′to plasm (prō′tô plăz′m). A colorless material of which all living things are made (p. 269)

pyr′a mid (pĭr′ȧ mĭd). A large structure, usually with a square base, the walls of which meet in a point. The Pyramids of Egypt were built to be used as tombs (p. 176)

qui′nine (kwī′nīn). A medicine made from the bark of a certain kind of tropical tree, which is used in the treatment of malaria (p. 288)

rain for′est (rān fŏr′ĕst). A tropical forest where the plants grow very thickly because of the great amount of rain (p. 141)

re flect′ (rē flĕkt′). To give back. When an object throws back light which falls on it, the object is said to reflect light (p. 13)

rep′tile (rĕp′tĭl). A cold-blooded animal with scales or a scale-like covering, which breathes with the use of lungs all its life (p. 327)

run′ner (rŭn′ẽr). A slender branch which grows out over the surface of the ground from the parent plant. A new plant grows at the end of or at certain places along the runner (p. 300)

sanc′tu ar′y (săngk′t͟ū ĕr′ĭ). A place especially set aside for animals, in which they cannot be harmed by man (p. 363)

se′pal (sē′păl). One of the small green leaves which protect a flower bud and which remain just under the petals when the flower opens (p. 293)

sep a ra′tion lay′er (sĕp ȧ rā′shŭn lā′ẽr). A thin layer of cells which grows between the leaf and the stem in the late summer or early fall (p. 65)

skel′e ton (skĕl′ė tŭn). The bones of an animal (p. 316)

sol′id (sŏl′ĭd). A substance which keeps its shape at ordinary temperatures (p. 26)

source (sōrs). The beginning of a thing (p. 12)

sperm cell (spûrm sĕl). The cell which fertilizes an egg cell (p. 294)

spore (spōr). A single cell or group of cells, formed on some kinds of plants such as ferns, from which new plants of the same kind will grow (p. 279)

sta′men (stā′mĕn). The part of a seed-making plant which produces pollen (p. 294)

stream′line (strēm′līn). To make the outside of a body as smooth as possible so that it can go through air or water more easily (p. 162)

sym′bol (sĭm′bŭl). A sign which may be used instead of a certain word or words (p. 222)

tel′e scope (tĕl′ē̇ skōp). An instrument which makes it possible to see far more stars and other very distant objects in the sky than we could see without it (p. 5)
tem′per ate (tĕm′pẽr ĭt). Neither hot nor cold; mild (p. 106)
tem′per a ture (tĕm′pẽr ȧ t͜ū̇r). The measure of heat of anything (p. 11)
the′o ry(thē′ō̇ rĭ). The best guess we can make from known facts in order to explain something (p. 248)
ther mom′e ter (thẽr mŏm′ē̇ tẽr). An instrument used to measure temperature (p. 10)
thun′der head (thŭn′dẽr hĕd). A large, dark, rounded cloud often appearing before a thunderstorm (p. 203)
top′soil (tŏp′soil). The soil on the surface of the earth (p. 125)
tor na′do (tôr nā′dō). A very strong whirling wind with a funnel-shaped cloud. A tornado is very destructive (p. 207)
trop′i cal (trŏp′ĭ kăl). Very warm; hot; being within the tropics (p. 106)
tset′se fly (tsĕt′sē̇ flī). An African fly which carries the germs that cause man to have sleeping sickness (p. 145)

va′por (vā′pẽr). A gas. Steam is water vapor. Anything turns to vapor if it is hot enough (p. 195)
vein (vān). A tube in a leaf which carries liquid (p. 61)

warm′-blood′ed an′i mal (wôrm′-blŭd′ĕd ăn′ĭ măl). An animal whose blood remains at a certain temperature. Dogs, cats, cows, and birds are warm-blooded animals (p. 336)
wind scale (wĭnd skāl). A table of words or numbers used to tell the force of the wind (p. 217)

yeast (yēst). A one-celled plant which cannot make its own food. Yeast is often used to make bread rise (p. 272)

zinc (zĭngk). A bluish-white metal. Zinc is the metal which is used to make the can of a dry cell (p. 237)
zone (zōn). One of the five great divisions of the earth's surface. The five divisions are the torrid zone, two temperate zones, and two frigid zones (p. 106)

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